THE NATIONAL BROADBAND PLAN: DEPLOYING QUALITY BROADBAND SERVICES TO THE LAST MILE

HEARING

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY, AND THE INTERNET

OF THE

COMMITTEE ON ENERGY AND COMMERCE
HOUSE OF REPRESENTATIVES

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THE NATIONAL BROADBAND PLAN: DEPLOYING QUALITY BROADBAND SERVICES TO THE LAST MILE

WEDNESDAY, APRIL 21, 2010

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY, AND THE INTERNET,
COMMITTEE ON ENERGY AND COMMERCE,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:05 a.m., in Room 2322 of the Rayburn House Office Building, Hon. Rick Boucher [Chairman of the Subcommittee] presiding.

Present: Representatives Boucher, Markey, Rush, Eshoo, DeGette, Doyle, Inslee, Butterfield, Christensen, Castor, Space, Welch, Dingell, Waxman (ex officio), Stearns, Upton, Shimkus, Buyer, Terry, Blackburn, Griffith, and Latta.

Staff present: Roger Sherman, Chief Counsel; Tim Powderly, Counsel; Amy Levine, Counsel; Shawn Chang, Counsel; Greg Guice, Counsel; Sarah Fisher, Special Assistant; Bruce Wolpe, Senior Advisor; Phil Barnett, Staff Director; Mitch Smiley, Special Assistant; Elizabeth Letter, Special Assistant; Neil Fried, Minority Counsel; Will Carty; Minority Professional Staff; Garrett Golding, Minority Legislative Analyst.

OPENING STATEMENT OF HON. RICK BOUCHER, A REPRESENTATIVE IN CONGRESS FROM THE COMMONWEALTH OF VIRGINIA

Mr. BOUCHER. Good morning to everyone. We are conducting this morning the second in a series of hearings focusing on the National Broadband Plan, and I want to commend the members of the Federal Communications Commission and their staffs for the truly outstanding job that they have done in compiling this plan sorting through thousands of comments that have been received from the public and providing very thoughtful work and good recommendations to the Congress. The United States stands 16th today among developed nations in broadband usage and for the benefit of our national economy and for our national quality of life, we need to do better.

In preparing the National Broadband Plan the Commission has made a major contribution to our effort to evaluate our national standing to a far higher number, and we are appreciate to the Commission for that work. Broadband in the 21st Century is as important as telephone service or electricity service were when they were first introduced more than a century ago. Today's hearing focuses on how best to deploy broadband to areas that are unserved and underserved so that all Americans, including those in the rural regions of our nation, may benefit from this truly essential infrastructure. We want to ensure that everyone has access to broadband and we also want to ensure that everyone has access at meaningful speeds and at truly affordable prices.

The National Broadband Plan reports that 95 percent of American homes have access to terrestrial fixed broadband infrastructure capable of supporting actual download speeds of at least 4 megabits per second, leaving approximately 7 million homes unserved. I have serious concerns about the accuracy of that number and the methodology that was employed in order to derive it. It is my understanding that for cable modem service the broadband team looked at maps of where every cable operator is authorized to provide service. The broadband team assumed that a cable operator should have built out to its entire service territory. It also assumes that each provider was using at least DOCSIS 2.0 technology, which would mean that every home within the service area could get broadband speeds of at least 4 megabits per second downstream and 1 megabit per second upstream.

Unfortunately, not every cable operator has deployed service throughout its franchise area, and not every cable operator has upgraded to DOCSIS 2.0 technology. For DSL service offered by phone companies, the broadband team relied on broadband maps from states that have already completed those maps. The team calculated where homes should be able to receive DSL service of at least 4 megabits per second downstream, 1 megabit upstream based on where those maps indicated there is a broadband infrastructure in place. The team also estimated that homes within a certain number of feet of central offices should be able to receive broadband. The team then extrapolated those figures to the entire nation.

Unfortunately, I think the experience is very different. In my own example with my constituency in Virginia the broadband map that was provided in my home state of Virginia has proven to be less than satisfactory as a genuine predictor of where broadband can be found. The map is based on data provided by the telephone companies and it over reports the availability of broadband in my district, and I am sure elsewhere. I frequently hear complaints from constituents who live in communities that the Virginia broadband map indicates are served, yet these constituents are persistently asking for broadband service because today they have none.

To the extent that the team extrapolated data from the Virginia broadband map and others like it, I can't, based on my experience, consider those projections to be reliable. I appreciate that Ms. Gillett will testify in her testimony today that the 95 percent figure is intended to be an estimate of homes that should have access to broadband based on what is estimated about where incumbent providers have deployed the infrastructure. It does not mean that someone in an area the broadband plan predicts would have broadband service could actually pick up a phone and call their service provider and receive broadband service. That is an important clarification and one that I hope all members will keep in mind as we develop policies that are based on the assumptions of broadband availability.

As we will hear from other witnesses on today's panel, there remain many areas of our nation without access to broadband or with access to broadband only at slow speeds and at high prices. It is far too soon to declare mission accomplished with respect to the goal of making broadband available to all Americans. I want to thank our witnesses for joining us this morning. We look forward to your testimony. And at this time, I am pleased to recognize the gentleman from Florida, Mr. Stearns.

[The prepared statement of Mr. Boucher follows:]

STATEMENT OF CONGRESSMAN RICK BOUCHER

Subcommittee on Communications, Technology and the Internet Hearing
The National Broadband Plan: Deploying Quality Broadband Services to the Last Mile

April 21, 2010

This morning we conduct the second in a series of hearings focusing on the National Broadband Plan. I want to commend the FCC for the thoughtful work that underlies the plan.

The United States stands today 16th among developed nations in broadband usage, and for the benefit of our national economy and quality of life we must do better. In preparing the National Broadband Plan, the Commission has made a major contribution to our effort to elevate our national standing to a far higher number.

Broadband in the twenty-first century is as important as telephone and electricity were when they were first introduced more than a century ago. Today's hearing focuses on how to best deploy broadband to areas that are unserved and underserved, so that all Americans, including those in rural areas, may benefit from this essential infrastructure. We want to ensure that everyone has access to broadband, and we also want to ensure that everyone has access at meaningful speeds and affordable prices.

The National Broadband Plan reports that 95 percent of American homes have "access to terrestrial, fixed broadband infrastructure capable of supporting actual download speeds of at least 4 mbps," leaving 7 million homes unserved. I have serious concerns about the accuracy of this number and the methodology the Broadband Team used to derive it.

It is my understanding that for cable modem service, the Broadband Team looked at maps of where every cable operator is authorized to provide service. The Broadband Team assumed that a cable operator should have built out to its entire service territory. It also assumed that each provider was using at least DOCSIS 2.0 technology, which would mean that every home within the service area could get broadband speeds of at least 4 mbps downstream and 1 mbps upstream.

Unfortunately, not every cable operator has deployed service throughout its franchise area, and not every cable operator has upgraded to DOCSIS 2.0 technology.

For DSL service, the Broadband Team relied on broadband maps from states that have already completed them. The Team calculated where homes should be able to receive DSL service of at least 4 mbps downstream and1 mbps upstream based on where those maps indicated there is broadband infrastructure. The Team also estimated that homes within a certain number of feet of central offices should be able to receive broadband. The Team then extrapolated those figures to the entire country.

Unfortunately, my experience with the completed broadband map in my home State of Virginia has been less than satisfactory. The map is based on data provided by the telephone companies, and it over-reports the availability of broadband in my district and I'm sure elsewhere. I frequently hear complaints from constituents who live in communities that the Virginia broadband map indicates are served, yet these constituents are persistently asking me for broadband service because they have none.

To the extent that the Broadband Team extrapolated data from the Virginia broadband map and others like it, I cannot, based on my experience, consider it reliable.

I appreciate that Mrs. Gillett will clarify in her testimony that the 95 percent figure is intended to be an estimate of homes that *should* have access to broadband based on what is estimated about where incumbent providers have deployed infrastructure. It does not mean that someone in an area the Broadband Plan predicts would have broadband service could pick up the phone, call their provider and get service. This is an important clarification, and one I hope all Members will keep in mind as we develop policies based on assumptions of broadband availability.

As we will hear from other witnesses on today's panel, there remain many areas of our Nation without access to broadband or with access to broadband only at slow speeds or high prices. It is far too soon to declare "mission accomplished" with respect to the goal of making broadband available to all Americans.

I want to thank our witnesses for joining us this morning. We look forward to your testimony.

OPENING STATEMENT OF HON. CLIFF STEARNS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mr. STEARNS. Good morning, and thank you, Mr. Chairman. First of all, Mr. Chairman, I would like to welcome Bob Latta from Ohio. He is on our committee and will recognize him and welcome him to this great subcommittee. His predecessor Bill Gilmore and I came in together, and he served on this committee too, so we are delighted to have you. I think all of us in this room and all of the folks on the committee would agree that there is tremendous benefits from broadband. Reaching 100 percent on the present broadband is a laudable goal. Most of us wonder what is the best way to do it, and I think a lot of us think that it can be done through private investment, much like we see either the iPhone or the iPad or the iTunes or the multiple of devices just pick up and everybody has them whether you are in rural or urban areas because the incentives are there.

For the United States to achieve this ubiquitous broadband deployment, I believe the private sector will have to show the bulk of the financial burden, and our policies on this committee should reflect that. As you mentioned, according to the broadband plan, approximately 290 million Americans or 95 percent, as you mentioned, Mr. Chairman, the population have access to at least 4 megabits per second broadband service while approximately 2/3 of all Americans, about 200 million people, subscribe to broadband.

This is up from 8 million 10 years ago, so you can see that it is moving forward. All these numbers demonstrate our free market pro-investment approach to broadband that it is working. Even if the government took no action the broadband plan concludes that private sector investment will provide 90 percent of the country with access to peak download speeds of more than 50 megabits per second by the year 2013. Now if the past decade of broadband investment is any guide, the private sector will likely take us the rest of the way to the broadband plan goal of reaching 100 million households with 100 megabytes per second service by 2020 simply letting the private investment pursue its way.

Although reaching that goal will cost approximately $359 million, the cable, telephone, and wireless industries have been investing $60 billion a year in broadband, suggesting we could hit the investment target within 6 years. That is $350 billion. The recent D.C. Circuit ruling that struck down the FCC attempt to regulate Comcast network management of internet congestion should further caution straying from our deregulatory approach. Even after the decision, the FCC still has plenty of explicit authority to implement the broadband plan that they put out. In rejecting the FCC's argument, the D.C. Circuit explained "statements of congressional policy can help delineate the contours of statutory authority." Congress issued such a policy statement in 1996 when it added Section 230 to the Communications Act.

My colleagues, that section makes it the policy of the United States to "preserve the vibrant and competitive free market that presently exists for the internet and other interactive computer services unfettered by federal or state regulations." So whether to revisit that legislative policy which the broadband plan data confirms has worked so well is a matter for Congress and not the

FCC's position. This does not mean, of course, that the government has no role. If we are going to subsidize broadband deployment it makes sense to concentrate on the 5 percent of the population, about 7 million homes, that do not have access to broadband, not the 95 percent that already do. We can target the unserved homes with an FCC universal service program that has been significantly reformed perhaps along the lines outlined in the broadband plan.

We can also use wireless and satellite services that might better reach those hard to serve places, including tribal lands. Government intervention is only appropriate, however, to target those homes that are otherwise uneconomic for the private sector to reach out and serve. To do otherwise would force the private sector to compete against the government or government-funded entities. Such skewing of market forces will only harm investment and innovation in the long run. What Congress and the FCC must do is not revert to failed regulatory ideas that were designed for old technologies in a monopoly ear marketplace.

Imposing network neutrality, for example, forcing access to facilities and regulating rates are the surest way to deter the investment we need to reach the broadband plan's goal. The benefit of quality of broadband, I think is obvious to all of us. It is important that all Americans, whether in a big city, a rural community or tribal land have access to this technology. That I agree. The question remains how do we get there? I don't think we should let this opportunity pass us by. Mr. Chairman, I think there is a great opportunity with these witnesses, and I look forward to hearing their opening statements. Thank you.

Mr. BOUCHER. Thank you very much, Mr. Stearns. The chairman of the Energy and Commerce Committee, the gentleman from California, Mr. Waxman, is recognized for 5 minutes.

OPENING STATEMENT OF HON. HENRY A. WAXMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. WAXMAN. Thank you very much, Mr. Chairman. Thank you for holding this hearing on deploying broadband service to unserved and underserved communities across the nation. Because broadband is critical to future economic growth and job creation every American must have the opportunity to access high quality, high speed broadband from a variety of providers. The plan provides a blueprint on how the public sector policies can promote deployment to both unserved and underserved communities. It also speaks to ways in which the private sector can act. By utilizing all the tools the public and private sectors have at their collective disposal, we could achieve a primary goal of the National Broadband Plan, 99 percent access to high speed broadband within 10 years.

While there are a number of proposals in the plan, I would commend the FCC staff for their thoroughness, and I would like to take a moment to highlight a couple that I find to be promising. For example, the plan recognizes that substantial cost savings can occur from better planning and coordination among government resources and recommends that all federally-funded rights-of-way projects include a broadband conduit at the time of construction.

This proposal is similar to legislation introduced by Congresswoman Eshoo, of which I am a co-sponsor.

Greater access to rights-of-way at reduced cost can help spur the deployment of advanced facilities, not only in urban areas but also deeper into rural areas. The plan also highlights specific ways in which the federal universal service system can be reformed, and I am very encouraged by these proposals. The obvious goal is to transform the fund to support broadband networks so that all Americans have access, and I am encouraged that the FCC is initiating the first of these proceedings in its open meeting that is occurring this morning. I am also encouraged that Chairman Boucher is working on draft legislation to help achieve this goal, and I am supportive of his efforts.

The plan also recommends addressing the data roaming issue. Consumers will be well served by common sense reform in this area. And, finally, I would like to commend the FCC for putting forward a proposed time line of its implementation schedule for the many proposals in the plan. This is the first time the FCC has so clearly outlined its work schedule, and I think that this approach is consistent with the chairman's view that the FCC should be as open and transparent as possible. Thank you again, Mr. Chairman, for holding this hearing, and I look forward to the testimony of our witnesses.

[The prepared statement of Mr. Waxman follows:]

ONE HUNDRED ELEVENTH CONGRESS

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COMMITTEE ON ENERGY AND COMMERCE

2125 RAYBURN HOUSE OFFICE BUILDING

WASHINGTON, DC 20515–6115

MAJORITY (202) 225-2927
FACSIMILE (202) 225-2525
MINORITY (202) 225-3641

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Opening Statement of Rep. Henry A. Waxman
Chairman, Committee on Energy and Commerce
National Broadband Plan: Deploying Quality Broadband Services to the Last Mile
Subcommittee on Communications, Technology, and the Internet
April 21, 2010

Thank you, Mr. Chairman, for holding this hearing on deploying broadband service to unserved and underserved communities across the nation. Because broadband is critical to future economic growth and job creation, every American must have the opportunity to access high-quality, high-speed broadband from a variety of providers.

The Plan provides a blueprint on how public sector policies can promote deployment to both unserved and underserved communities. It also speaks to ways in which the private sector can act. By utilizing all the tools the public and private sectors have at their collective disposal, we can achieve a primary goal of the National Broadband Plan – 99 percent access to high-speed broadband within ten years.

While there are a number of proposals in the Plan, and I commend the Federal Communications Commission (FCC) staff for their thoroughness, I would like to take a moment to highlight a couple that I find to be promising. For example, the Plan recognizes that substantial cost savings can occur from better planning and coordination among government resources and recommends that all federally-funded rights-of-way projects include a broadband conduit at the time of construction. This proposal is similar to legislation introduced by Congresswoman Eshoo of which I am a cosponsor. Greater access to rights-of-ways at reduced costs can help spur the deployment of advanced facilities not only in urban areas, but also deeper into rural areas.

The Plan also highlights specific ways in which the federal universal service system can be reformed, and I am very encouraged by these proposals. The obvious goal is to transform the fund to support broadband networks so that all Americans have access, and I am encouraged that the FCC is initiating the first of these proceedings at its Open Meeting that is occurring this morning. I am also encouraged that Chairman Boucher is working on draft legislation to help achieve this goal, and I am supportive of his efforts.

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Finally, I would like to commend the FCC for putting forward a proposed timeline of its implementation schedule for the many proposals in the plan. This is the first time the FCC has so clearly outlined its work schedule, and I think that this approach is consistent with the Chairman's view that the FCC should be as open and transparent as possible.

Thank you again, Mr. Chairman, for holding this hearing, and I look forward to hearing from our witnesses.

Mr. BOUCHER. Thank you very much, Chairman Waxman. The gentleman from Illinois, Mr. Shimkus, is recognized for 2 minutes.

OPENING STATEMENT OF HON. JOHN SHIMKUS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. SHIMKUS. Thank you, Mr. Chairman. I appreciate this hearing. I appreciate the panel, and hopefully I will get a chance to sit in to a lot of the discussion. I am personally conflicted about the broadband plan. I will try to be a little more calm than I was when the FCC was sitting before us. And there are a couple of issues. Whether the number is 7 million or whether it is larger, the real issue is before we deploy we ought to map, and we didn't do that, so we have the cart before the horse, so that is issue one. I have been talking numerous times about let us define what the goal is that we are trying to achieve and what speed is going to be the standard, whether it is 4, 100, whatever, let us get a definition so that we know what we are trying to achieve.

We ought to roll out—government intervention is only appropriate when we want to target those homes that are otherwise uneconomic for the private sector to serve. I reject this argument that it is government's role to provide a variety of providers, and what we see going on is with government taxpayer dollars, we are overbuilding in areas creating a competitive market against incumbent providers already when we have at a minimum 7 million people who don't have access. So those of us who represent rural areas who may be on dial-up, the appropriate place for government money is like we do in the Universal Service Fund to use government help to roll out to areas that are not economic for an individual entity to do, not to overbuild and compete with other traditional providers right now.

So we have a long way to go. We are wasting time and we are wasting money to get deployment out to rural America. So, Mr. Chairman, it is timely, and we will be watching this process as it moves forward. Thank you.

Mr. BOUCHER. Thank you very much, Mr. Shimkus. The gentleman from Michigan, Mr. Dingell, Chairman Emeritus of the Energy and Commerce Committee, is recognized for 5 minutes.

OPENING STATEMENT OF HON. JOHN D. DINGELL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MICHIGAN

Mr. DINGELL. Mr. Chairman, I thank you for convening today's hearing on the last mile broadband development. It is very important. I fully support the important cause of providing all Americans with access to broadband communications. All the same, we must ensure that such federal program implemented to do so is based on accurate date and grounded in appropriate statutes. There seems to be some confusion concerning the actual level of last mile broadband infrastructure deployment and adoption across the United States. I would remind my colleagues that deployment and adoption are not synonymous with one another, and welcome any clarification on this matter our witnesses can provide. As many of them have rightly noted, accurate data is invaluable to the proper design and functioning of any future broadband support mechanism. It is also dispensable to proper administration by the agencies concerned.

We must also ascertain whether existing statutes are adequate to the task of establishing new and functioning support mechanisms to ensure that all Americans have access to broadband communications. I note that the National Broadband Plan recommends broadening of the Universal Service Fund contribution base. I hope our witnesses, especially Ms. Gillett of the Federal Communications Commission, will provide the members of this subcommittee with their candid opinions concerning the extent to which the commission's statutory authority currently permits this. Should it not, I again remind our witnesses that the Congress is the sole progenitor of the commission's authorities and should be consulted if new powers are to be conferred or exercised.

In closing, I would like to thank the witnesses for appearing before us this morning to allow the members of the subcommittee to avail themselves of the expertise of our witnesses. To our witnesses' dismay, I am sure, I will submit my questions, many of them yes or no, for the record, and ask unanimous consent at this time, Mr. Chairman, that I be permitted so to do. I also look forward to continued debate on this matter and other matters related to the implementation of the National Broadband Plan. I thank you for the courtesy that you extended me this morning, Mr. Chairman. I commend you for the hearing, and I yield back the balance of my time.

Mr. BOUCHER. Thank you very much, Chairman Dingell. The gentleman from Alabama, Mr. Griffith, is recognized for 2 minutes.

OPENING STATEMENT OF HON. PARKER GRIFFITH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ALABAMA

Mr. GRIFFITH. I would like to thank the chairman and ranking member for calling this hearing today and also thank all of the witnesses for your willingness to testify before this committee. Currently 95 percent of Americans have broadband access and only 5 percent do not. We on this committee realize that this is an issue of unserved versus underserved. I am here today to advocate for deployment of broadband to he unserved areas of our country and assure that we properly qualify unserved and underserved. It is imperative that any policies we discuss foster competition.

In today's business market, access to broadband is vital from the boardroom to the farm, and everywhere in between. I believe that we have been moving in the right direction with the deployment of broadband. Free market principles and pro-investment policies have yielded 200 million subscribers, up from 8 million over just the last decade. Over the last 10 years private industry has invested over $500 billion in broadband deployment. That is a staggering number and one that confirms that those investments were vital to reaching the current 200 million subscribers. If we stay on this path and work together, I believe we can meet the goal of providing the remaining 100 million homes with access to broadband service by 2020. Again, I thank you for your time today, and I look forward to hearing your testimony.

Mr. BOUCHER. Thank you, Mr. Griffith. The gentleman from Massachusetts, Mr. Markey, is recognized for 2 minutes.

OPENING STATEMENT OF HON. EDWARD J. MARKEY, A REPRESENTATIVE IN CONGRESS FROM THE COMMONWEALTH OF MASSACHUSETTS

Mr. MARKEY. Thank you, Mr. Chairman. Thank you for having this very important hearing. Welcome, Bureau Chief Gillett. I have admired your work in Massachusetts over the years, and I am very proud to have you now take on this great national responsibility. As the lead House sponsor in 1996 of the E–Rate provision, I call it the E–Rate, I was going to call it the E–Rate but I didn't think I could get away with it, so I just call it the E–Rate, it is important for us to recognize that the children, that adults without broadband should have access in schools and in libraries, but increasingly because according to the FCC 14 to 24 million Americans do not have broadband accessible to them at all and another 93 million Americans have chosen not to purchase broadband even if it is available to them, we need strategies that can ensure that broadband does reach them.

And so this is a huge issue for us. The OECD has said that we have dropped to 15th in world rankings in broadband deployment, so what I think we have to do is relying upon this National Broadband Plan to have this discussion. We have to devise ways that we harness new advances in technologies, insist on administrative efficiencies inside of the programs in order to drive down costs and to create savings wherever possible, and we need to shift over time to a more rational, stable source of funding while embracing broadband as a service that all Americans should be entitled to. It will become the indispensable infrastructure for the 21st Century in our country and around the world. It will be a proxy for economic growth in all sectors, energy, health care, education, all parts of the American economy.

If we want to be number 1 for the 4 percent of our population as opposed to the other 96 percent of the world, we just have to decide if broadband is going to be at the center of that national strategy. This hearing will go a long way towards helping us to establish a long-term plan. Thank you, Mr. Chairman.

Mr. BOUCHER. Thank you very much, Mr. Markey. The chair would like to add its welcome also to the gentleman from Ohio, Mr. Latta, as a new member of our subcommittee. We look forward to working with you, and you are recognized for 2 minutes.

OPENING STATEMENT OF HON. ROBERT E. LATTA, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OHIO

Mr. LATTA. Thank you very much, Mr. Chairman. It is an honor for me to be on this subcommittee. I look forward to working with you and the other members on the subcommittee. I represent one of the most rural areas in the State of Ohio, and I am keenly aware of the importance broadband deployment plays in the economic development and in the nexus that this axis has the job creation. I feel very strongly that the country's free market private investment approach to broadband expansion has been very successful. It is also my understanding that according to the National Broadband Plan 95 percent of the population has at least 4 megabyte per second broadband service. I believe that the remaining 5 percent for service should be spent on the unserved areas where areas do not have access to broadband.

We need to carefully look at how to expand service to ensure that there is not an unfair advantage to one entity, especially in light of the fact that private industry has invested billions of their own capital to expand services. Additionally, I am concerned how the FCC will define competition with the structure of the plan. Furthermore, the plan has called for greater collection analysis of the competition data. This is a bit worrisome as companies are essentially being asked to hand over their proprietary data and potentially fuel competition to their services by the government or their private sector counterparts.

There must be safeguards put in place and an assurance that the government does not get in the business of competing with this already hyper competitive industry. It is important that while serving to reach this remaining 5 percent of the unserved household, that jobs are indeed created. I am critical of increasing bureaucratic red tape through any government initiative when the free market can do better. We need to assure that any of the requirements are not detrimental to job creation in Ohio or across the country. Broadband expansion can help the economy by creating new jobs related to the deployment of necessary infrastructure, as well as by giving unemployed workers access to tools that will help them find and prepare for new jobs.

It is my hope that the FCC does indeed focus on broadband deployment which will bring jobs and economic development to rural areas and not focus on policy or if the FCC has questionable authority. I want to thank the chairman again for this opportunity. I look forward to hearing the testimony from the witnesses. I yield back.

[The prepared statement of Mr. Latta follows:]

Congressman Robert E. Latta
The Committee on Energy & Commerce
Subcommittee on Communications, Technology & the Internet
Opening Statement – For the Record

MR. CHAIRMAN; RANKING MEMBER STEARNS: Thank you, it is an honor to be the most recently appointed member of the Energy & Commerce Committee and I am pleased to have been appointed to the Communications, Technology & the Internet Subcommittee. I look forward to working with all of you on the important issues before this subcommittee.

Representing one of the most rural areas of Ohio, I am keenly aware of the importance broadband deployment plays in economic development and the nexus this access has to job creation. I feel very strongly that the country's free-market, private investment approach to broadband expansion has been very successful. It is my understanding, that according to the national broadband plan, 95% of the population has at least 4 megabit-per-second broadband service. I believe that the remaining 5% stretch for service should be spent on "unserved" areas, where areas do not have access to broadband.

We need to carefully look at how to expand service to ensure that there is not an unfair advantage to any one entity, especially in light of the fact that private industry has invested billions of their own capital to expand services. Additionally, I am concerned with how the FCC will define "competition" within the structure of the plan. Furthermore, the plan has called for greater collection and analysis of competition data. This is a bit worrisome to me as companies are essentially being asked to hand over their proprietary data to potentially fuel competition to their services by the government or their private sector counterparts. There must be safeguards put in place and an assurance that the government does not get into the business of competing with this already hypercompetitive industry.

It is imperative that while striving to reach this remaining 5% of the unserved households, that jobs are indeed created. I am critical of increasing bureaucratic red tape through any government initiative, when the free market can do it better. We need to ensure that any new requirements are not detrimental to job creation in Ohio and across the country. At a time when the unemployment rate is over 12% in many parts of my District, we need to work towards creating new, high paying jobs. Broadband expansion can help the economy by creating new jobs related to the deployment of the necessary infrastructure, as well as by giving unemployed workers access to tools that will help them find and prepare for new jobs. I am hopeful this will be the case, as the so called "stimulus bill", or ARRA, has done anything but create an environment that is conducive to job growth in Ohio. On the contrary, we have seen a continued increase in the unemployment rate since the bill was signed into law. It is my hope that the FCC does indeed focus on broadband deployment, which will bring jobs and economic development to rural areas, and not focus on policy areas where the FCC has questionable authority.

Mr. Chairman, thank you for this opportunity, and I look forward to hearing the testimony from the witnesses on the panel today. [Yield Back]

Mr. BOUCHER. Thank you very much, Mr. Latta. The gentle lady from California, Ms. Eshoo, is recognized for 2 minutes.

OPENING STATEMENT OF HON. ANNA G. ESHOO, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Ms. ESHOO. Thank you, Mr. Chairman, for scheduling this hearing to continue to explore options for deploying broadband in ways that all Americans, not just some, but all Americans will have access to it. The National Broadband Plan makes inclusion an essential priority with a goal of reaching, as we know, 100 million households with 100 megabits per second service by 2020. I think that this is an ambitious plan, and I think it is just what we need to do. We need to be ambitious given, as you stated earlier, our 16th position in the world. We can't afford to leave some Americans in the dust while others move ahead with broadband access in a way that turns the underserved and the unserved regions of our nation into virtual reality ghost towns.

I am pleased that the National Broadband Plan contains ideas already offered by members. I introduced one that would require broadband conduit to be installed for federal highway projects. It is the dig once concept, which is what I call it anyway, and I think it makes sense from the financial and administrative sense. We can guarantee the infrastructure that goes where our highway system goes and reap the cost savings of doing a 2 for 1 dig. And so I hope to see this move. I think it is smart. I think it makes sense. It is pragmatic, and I look forward to seeing it happen.

Inclusion and access can't be achieved without funding, and I think that we need to update the Universal Service Fund to recognize broadband as a primary communications tool. Certainly, Representative Matsui's bill moves in that direction. I support it. Mr. Markey's bill, which takes the E-Rate program to the next level, I am proud to support. So I think that we need to build in these pieces of legislation in order to keep moving ahead. We are only going to reach the last mile, in my view, with a unified sense of purpose. As I look out at the witnesses here today there is a diverse range of interest, and I am looking forward to hearing how you see us reaching and serving the last mile in a way that is inclusive and affordable. So thank you, Mr. Chairman, for continuing this series of hearings. They are most valuable, obviously, on the broadband plan, and I can't wait for the implementation phase. I yield back.

Mr. BOUCHER. Thank you very much, Ms. Eshoo. The gentle lady from the State of Tennessee, Ms. Blackburn, is recognized for 2 minutes.

OPENING STATEMENT OF HON. MARSHA BLACKBURN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TENNESSEE

Ms. BLACKBURN. Thank you, Mr. Chairman, and I thank you for the hearing and for the focus that we have on this issue. And I want to say welcome to all of you who are before us today. We are glad you are here. I will tell you if we had been doing our work in the manner in which we should have been, you would not have to be here today. We do need to put our attention on the 7 million people that do not have access to broadband, and that should be the focus of our attention. But we should have gone about our mapping processes first and then we should have issued the definitions of what unserved and underserved were going to be. Instead, this committee after much discussion, decided that that would be booted to the FCC who then decided they would boot it on to others.

So we need to look at where we are placing the ability to determine what this is. Now do local governments have a role to play in this? They do, but they don't need to be competing with private companies. That is why we need to be looking at these definitions, and then making a determination how we go about with completing the rest of this broadband access but not driving up costs for the consumer. I am looking forward to hearing what you all have to say, and welcome to the committee. Mr. Chairman, I yield back.

[The prepared statement of Ms. Blackburn follows:]

Honorable Marsha Blackburn (TN-07)
Committee on Energy and Commerce
Subcommittee on Communications, Technology, and the Internet
Hearing: "The National Broadband Plan: Deploying Quality Broadband Services to the Last Mile"
Opening Statement
April 21, 2010

Thank you, Mr. Chairman. It has been very well documented that 95% of the country has access to Broadband. Therefore, I need to reiterate my belief that we need to spend our time focusing on the 5% of the country (or more specifically, the 7 million homes) that do not have access to Broadband services.

There is no doubt that municipalities can not provide broadband as well, or as efficiently, or as economically competitively as private companies However, there is a role for the government to get involved in these remote areas where private investment is not occurring. But again, municipalities must focus their role in areas where it is otherwise economically unappealing for private investment. We don't need government competing with the private sector. This would only drive up costs and take away good paying jobs.

I look forward to hearing from each of the panelists and discussing how we can best work to insure that we connect broadband to the unserved before we refocus our efforts on the underserved.

I yield back the balance of my time.

Mr. BOUCHER. Thank you very much, Ms. Blackburn. The gentle lady from the Virgin Islands, Ms. Christensen, is recognized for 2 minutes.

OPENING STATEMENT OF HON. CLIFF STEARNS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mrs. CHRISTENSEN. Thank you, Chairman Boucher, and Ranking Member Stearns for this second hearing on the National Broadband Plan. As a representative of a district that is second to last in broadband penetration the implementation of the last mile is very important to my constituents as it is to tribal areas and many communities of color who I am sure make up much of the 14 to 24 million Americans to whom broadband is unavailable or the 93 million or more who are not using it. These communities are at a health, educational, and economic disadvantage, and so the optimal deployment of the last mile as well as the middle mile and efforts to increase adoption are critical if our communities are to thrive and our nation is to remain competitive.

I think that the National Broadband Plan's recommendation to expand universal service program to cover broadband and the expansion of the Community Connect program are a great start. I look forward to the discussions on these and other recommendations during this hearing, and while I recognize that this hearing is not specifically on BTOP or BIP they represent an immediate investment opportunity to the territories, many of which are long distances from the mainland and depend greatly on broadband deployment. To date only 2 grants were awarded to the territories in round one. It is my hope they will do better in round two because it is important that we get the funding to these areas. I would also like to welcome our witnesses and look forward to their testimony and the discussion on broadband funding and deployment today. Thank you.

Mr. BOUCHER. Thank you, Ms. Christensen. The gentleman from Nebraska, Mr. Terry, is recognized for 2 minutes.

OPENING STATEMENT OF HON. LEE TERRY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEBRASKA

Mr. TERRY. Thank you, Mr. Chairman, for holding this hearing, and I look forward to the series of hearings that we will have on the National Broadband Plan. That said, I do hope that the actual last mile wired line and wireless providers will be able to testify in future hearings. They are doing an excellent job according to the plan, which states that approximately 290 million Americans, 95 percent of the population, have access to at least 4 megabits per second broadband service. If we are going to meet the goals set out in the plan then it makes sense to have federal programs like the Universal Service Fund concentrate on the small 5 percent of the unserved population that do not have access to broadband.

These homes are primarily in very rural areas in which it is otherwise uneconomic for the private sector to serve. As we have seen by the massive investments made over the last decade, the private sector is more than willing to provide service to the rest of the country. It should come as no surprise to anyone in this room when I say I truly hope this committee will have the opportunity to advance a much-needed USF reform bill, and which the chairman and I have worked so hard on over the years. Again, I think you, Chairman Boucher, for holding this hearing and look forward to future hearings. I yield back the rest of my time.

Mr. BOUCHER. Thank you very much, Mr. Terry. The gentleman from Pennsylvania, Mr. Doyle, is recognized for 2 minutes.

Mr. DOYLE. Thank you, Mr. Chairman. I waive.

Mr. BOUCHER. Thank you. The 2 minutes will be added to your time for questioning our witnesses. The gentleman from North Carolina, Mr. Butterfield, is recognized for 2 minutes.

OPENING STATEMENT OF HON. G.K. BUTTERFIELD, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NORTH CAROLINA

Mr. BUTTERFIELD. Thank you, Mr. Chairman, for holding this hearing today on deploying broadband to the last mile. While the majority of Americans enjoy access to a fast broadband connection there is a significant segment that does not, and so my comments today will be for those who do not have access to broadband. Those who fall into that category either use dial up or simply go without the technology that connects us to the internet. These unserved and underserved regions should be of the highest concern to those who are charged with fulfilling Congress' intent of nationwide and universal broadband deployment and accessibility. I am concerned of the amount of BTOP and BIP funds that have been awarded to date. Out of the $7.2 billion appropriated to NTIA and RUS, only a little more than $2 billion has been awarded.

With a tremendous need, particularly in rural areas like mine, more must be done to expeditiously award qualified applicants. More than a dozen applications came from my district, yet only 1 statewide middle mile infrastructure project has been funded. That award will benefit my state by connecting anchor institutions, hospitals, and libraries, but will not benefit my constituents that still lack a home connection. The National Broadband Plan also recommends that municipalities lacking access to affordable broadband fill the void through a municipally-owned operator. This is already happening in a municipally-owned city in my district, Wilson, North Carolina, where Green Light, the city's municipally-owned broadband, is providing fiber to home for every customer at an affordable cost.

The city applied for round 1 of BTOP funds and was not funded and it does not qualify for BIP second round funding. Having invested $30 million of their own money, the city has built a successful world class system only to be denied federal assistance for its continued operation. Wilson is lucky to have been able to sustain themselves for so long, but other regions of the district simply go without access to the tools that we all take for granted. Mr. Chairman, my time has expired. I want to thank you for your leadership on this issue. I look forward to hearing from the witnesses. I yield back the balance of my time.

Mr. BOUCHER. Thank you, Mr. Butterfield. The gentleman from Vermont, Mr. Welch, is recognized for 2 minutes.

OPENING STATEMENT OF HON. PETER WELCH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF VERMONT

Mr. WELCH. Thank you very much, Mr. Chairman, and Ranking Member Stearns. Vermont is intimately familiar with the challenges of last mile broadband deployment. We have got close to 20 percent of Vermonters currently lacking access to high speed broadband, and the majority of Vermont lacks access to state of the art communication tools like Wi-Fi and town centers and mobile television services, so we have got a long way to go. And, of course, in this day and age access to broadband is no longer a luxury, it is a necessity, and for Vermont and other states like Vermont to compete in the 21st Century, we have got to take greater strides towards achieving universal access, and to fail in this effort would be to fail large slots of rural America, including Vermont.

So that is why I support the National Broadband Plan proposed reform of the Universal Service Fund and expansion of the Community Connect program. We have got to reach that goal of deploying broadband facilities capable of actual download speeds of 4 megabits upload speeds of 1 megabits to 99 percent of the unserved population by 2020. I am hoping to learn more today. I appreciate you being here and all of the work that you are doing and look forward to getting from where we are to where we need to be as quickly as possible. And I yield back.

Mr. BOUCHER. Thank you, Mr. Welch. The gentle lady from Florida, Ms. Castor, is recognized for 2 minutes.

OPENING STATEMENT OF HON. KATHY CASTOR, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Ms. CASTOR. Thank you, Chairman Boucher, for calling this hearing, and welcome to our witnesses. Since the Comcast BitTorrent case, many people have been wondering what is in store for the National Broadband Plan. The plan's overarching mission is very important, and that is to bring the tremendous power of the internet to all Americans, rural or urban, rich or poor, young or old. So in my view the last mile is not just about geography. There are millions of Americans, many of them in well-served communities like mine, who simply do not have the resources to take advantage of the world at their fingertips. In addition, the Universal Service Fund has served many telephone users well over the years but it is time for an update, and the plan aims to reform the USF and bring it into the broadband age, and I am supportive of these efforts.

Many of you have heard me mention before that Floridians over time have paid into the USF much more than we have received back and we need reform. I want to make sure that the funds are intended for broadband and adoption in the new versions of the USF are distributed more evenly across communities in the last mile in the truest sense of that phrase. I would also like to hear what the witnesses have to say about the FCC's ability to reform the USF in the post-Comcast BitTorrent world. We need to figure out if the FCC has the authority it needs to make changes to how we pay into the USF and expand it to include broadband.

Regulatory uncertainty is not good for business and it is not good for consumers, so now it is time for Congress and the FCC to dig in and do what it takes to bring the real world infrastructure that gets us to the last mile. Thank you all, and I look forward to your testimony. I yield back.

Mr. BOUCHER. Thank you, Ms. Castor. The gentleman from Illinois, Mr. Rush, is recognized for 2 minutes.

OPENING STATEMENT OF HON. BOBBY L. RUSH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. RUSH. Thank you, Mr. Chairman. I want to thank the ranking member and say good morning and welcome to each one of our witnesses here today. I want to thank you for appearing to offer your views on the program as well as your recommendations on how to best deploy broadband to individuals and families in unserved and underserved areas. In 1989 there was a blockbuster movie produced and directed by Kevin Costner called the Field of Dreams, and Kevin Costner plays an Iowa corn farmer, Ray Kinsella, who hears voices that tell him to build—if he would build it, he would come or they would come. Going on blind faith and his interpretation of what those voices have commanded of him, Ray invests extraordinary measures of times and resources to construct a baseball diamond in his corn field.

Nearly a year later, and following the jeers of neighbors and impending bankruptcy, his vision becomes manifest when the ghosts of Chicago White Sox, including the infamous Shoeless Joe Jackson, appear literally out of thin air to practice and play on that corn field diamond. The top leaders and management of communication companies have not only told us but are showing us time and time again that they are not like Ray Kinsella. Unlike Mr. Kinsella, they are not novices in business. Unlike Mr. Kinsella, these business leaders are driven by the prospects of generating hard cash assets and handsome returns for their shareholders. And, unfortunately, unlike Ray, some of these companies have lost touch with the vision of their own founders to be content with modest profits while erring on the side of consistently growing their networks through all economic cycles.

Just a generation or two ago, a large percentage of these companies and even public utilities were owned by a wider basis of shareholders. Many of these shareholders held but a few shares of stock in a given company and were content to know that their investment would provide them with predictable income and stable dividends. These wide bases have strengthened increasingly over the years and some of these companies have been reorganized so as to avoid or to minimize their public interest obligation and duties under the law. They are now comprised of smaller and smaller groups of extremely wealthy individuals and giant financial institutions whose interest in expanding their networks are inseparable from what the last few sets of quarterly profits on these companies' income statements show. Therein lies the rub, Mr. Chairman, and members of the subcommittee. How can we find that swing spot where network expansion and broadband deployment intersect with the motives of emerging and mature communications companies alike.

And I will be listening intently to what the witnesses have to say today in their testimony, and during the question and answer period to hear how best Congress can promote the goal of the National Broadband Plan, deploying broadband facilities to 99 percent of the unserved population by the year 2020. We are in 2010 now. Ten years isn't a lot of time. Let us start talking and start working and start making it happen. Thank you. I yield back the balance of my time.

Mr. BOUCHER. Thank you very much, Mr. Rush. The gentleman from Washington State, Mr. Inslee, is recognized for 2 minutes.

Mr. INSLEE. Thank you. I just want to note where the longest last mile is, which is in the tribal communities, and hope that we can discuss ways to advance finishing that longest last mile. We have got infrastructure challenges. We have got government relationship challenges. We have got some good progress with 57 tribes out in Washington. I think there are things we can do, and I hope we will talk about ways to get that done today. Thanks.

Mr. BOUCHER. Thank you, Mr. Inslee. The gentle lady from Colorado, Ms. DeGette, is recognized for 2 minutes.

Ms. DEGETTE. Mr. Chairman, these are obviously concerns that we share even in urban districts as I discussed at the last hearing. And with that, I will submit my opening statement and look forward to the testimony.

Mr. BOUCHER. Thank you very much, Ms. DeGette. We will add 2 minutes to your time for questioning our panel of witnesses. We turn now to our panel, and I want to welcome each of them. I will say just a brief word of introduction about each, and then we will be very pleased to hear from you. Sharon Gillett is the Chief of the Wireline Competition Bureau at the Federal Communications Commission, and was a participant in the construction of the National Broadband Plan. David Villano is the Assistant Administrator of the Telecommunications Program at Rural Development at the U.S. Department of Agriculture. Joe Garcia is the Regional Vice President for the National Congress of American Indians. Derek Turner is a Research Director for Free Press. Mark Dankberg is the Chairman and CEO of ViaSat, Inc. Austin Carroll is the General Manager of the Hopkinsville Electric System from Hopkinsville, Kentucky. And Jeffrey Eisenach is the Managing Director and Principal for Navigant Economics LLC.

We welcome each of you this morning, and without objection your prepared written statements will be inserted in the record. We would welcome your oral summaries and ask that you try to keep those to approximately 5 minutes. Ms. Gillett, we are glad to have you here. Congratulations on the fine work with the broadband plan, and we look forward to hearing from you.

STATEMENTS OF SHARON GILLETT, CHIEF, WIRELINE COMPETITION BUREAU, FEDERAL COMMUNICATIONS COMMISSION; DAVID VILLANO, ASSISTANT ADMINISTRATOR, TELECOMMUNICATIONS PROGRAM, RURAL DEVELOPMENT, U.S. DEPARTMENT OF AGRICULTURE; JOE GARCIA, REGIONAL VICE PRESIDENT, NATIONAL CONGRESS OF AMERICAN INDIANS; S. DEREK TURNER, RESEARCH DIRECTOR, FREE PRESS; MARK DANKBERG, CHAIRMAN AND CEO, VIASAT, INC.; AUSTIN CARROLL, GENERAL MANAGER, HOPKINSVILLE ELECTRIC SYSTEM; JEFFREY A. EISENACH, MANAGING DIRECTOR & PRINCIPAL, NAVIGANT ECONOMICS LLC

STATEMENT OF SHARON GILLETT

Ms. GILLETT. Thank you, Chairman Boucher, Ranking Member Stearns, and members of the subcommittee for the opportunity to testify today about broadband deployment as described in the National Broadband Plan. I am also submitting a technical paper that the FCC is publishing on the topic, and I request that it be made part of the record.

Mr. BOUCHER. Without objection.

[The information appears at the conclusion of the hearing.]

Ms. GILLETT. Thank you. As you know, the plan stems from a Congressional directive to ensure that all people in the U.S. have access to broadband capability. To meet that objective, the FCC needed to size the gap between current broadband deployment levels and the goal of deployment to everyone. Given the limited state of available data on broadband deployment, sizing the gap was not a simple task. It involved considerable effort to gather the best available data and incorporate it into a comprehensive model of the current status of broadband deployment. This model considers a housing unit to have access to broadband capability if it is close enough to today's telephone or cable network infrastructure such that a service provider can deliver broadband at actual speed of 4 megabits per second download and 1 megabit per second upload today.

The model estimates that 95 percent of the housing units in the U.S. can be served from today's infrastructure, meaning that about 14 million Americans cannot be served. Just because a housing unit can be served, however, does not mean that it is. There is no guarantee that a provider makes a retail service available to every home that its network is capable of serving. As a result, the actual number of citizens who cannot purchase broadband service is likely higher than 14 million. Limitations in the model data sources also contribute to sensitivities in the 95 percent estimate.

For example, we relied on public cable industry data, which estimates that 90 percent of housing units are reachable with cable-based broadband. This data attributes cable broadband availability to entire cable franchise areas if any part of the franchise area is served with two-way capability. This attribution is accurate in most, but not all, cases, and accordingly the 90 percent figure may be an overstatement. The plan's estimate of an additional 5 percent of housing units that are reachable only through telephone-based broadband is similarly based on limited data. The model relied on data for a number of states as an input to a statistical regression analysis that allowed us to adapt the conclusions from these states to the rest of the nation.

And I will add that exactly because of the kinds of concerns raised by Chairman Boucher, we did not rely on Virginia data as one of the states. As is generally the case though with statistical extrapolation there is also estimates rather than exact figures. As a complement to the broadband infrastructure modeling effort, we also analyzed FCC broadband subscribership data recognizing that such analysis is an imperfect means of assessing broadband availability. This analysis suggests that 92 percent of Americans live in areas where broadband service is offered, meaning that as many as 24 million Americans live in areas where broadband service is not offered.

Based on these 2 methods of sizing the broadband deployment cap, we conclude that broadband is unavailable to approximately 14 to 22 million Americans. The model developed for the plan also estimates the financial commitments needed to reach unserved homes and the likely resulting revenues. This financial modeling shows that for today's unserved homes, which are largely located in low density rural areas. The private sector business case to reach them simply does not add up. While the market has done a great job of getting broadband to much of America, market incentives alone will not be enough to reach the homes that remain unserved today. Just as the current Universal Service Fund was instrumental in ensuring the availability of telephone service to over 99 percent of Americans, so too will a financial commitment to universal broadband service be necessary to ensure that broadband availability surpasses 95 percent in the future.

Two helpful developments should improve data on the unserved. First, as a result of the Broadband Data Improvement Act, states are now gathering data about broadband deployment and by next February this data will be integrated into a national broadband map. Second, later this year the FCC will propose revisions to its broadband data gathering methodology consistent with recommendations in the plan. We look forward to working with Congress, industry representatives, and public interest advocates to fashion a new regime of broadband data collection that will provide Congress and the FCC with the relevant data we need while respecting industry's concerns regarding data that is legitimately competitively sensitive.

Allow me to conclude by sharing with you that when I served as a state commissioner, lack of broadband availability was the top constituent complaint for legislators from rural districts, and now such complaints are the most frequent correspondence I receive from members of this august body. The addresses are all over the country but the issues are the same. In homes without broadband children are at an educational disadvantage. Parents are shut out from jobs that require online applications and no one can access critical government information and services online. If you live in one of those homes, it matters little to you whether broadband is available to 90, 92 or 95 percent of Americans. What matters most is that broadband is not available to 100 percent of the home that you live in.

Solving that problem lies at the heart of the National Broadband Plan and reflects the very core of the FCC's mission in the 21st Century to work to make sure that America has world-leading high speed broadband networks. Thank you again for inviting me to testify and I will be happy to address any questions.

[The prepared statement of Ms. Gillett follows:]

Written Statement of
Sharon Gillett
Chief, Wireline Competition Bureau
Federal Communications Commission

"The National Broadband Plan: Deploying Quality Broadband Services to the Last Mile"

Hearing before the
Subcommittee on Communications, Technology, and the Internet
United States House of Representatives
April 21, 2010

Chairman Boucher, Ranking Member Stearns, Members of the Subcommittee, thank you for the opportunity to testify today about broadband deployment as described in the National Broadband Plan.

As you know, the Plan stems from a Congressional directive that the FCC prepare a "national broadband plan" that "shall seek to ensure that all people of the United States have access to broadband capability," include a strategy for affordability and adoption of broadband communications, and also recommend ways that broadband can be harnessed to tackle important "national purposes."

To meet the Plan's first objective of ensuring "that all people of the United States have access to broadband capability," it was necessary for the FCC to size the gap – that is, to determine the difference between where we are today on broadband deployment, and where the Congressional directive tells us we need to be, namely that "all people of the United States have access to broadband capability."

Sizing the gap was not a simple task, given the limited state of data that is currently publicly available about where broadband infrastructure and service are available in the United States. As a result, determining the current status of broadband deployment involved considerable effort to gather the limited but best available data and incorporate it into a model that used statistical techniques to extrapolate where necessary. All models have limits, as they depend upon assumptions regarding inputs and analyses. But the fact that no model is a perfect representation of reality does not diminish the value of models as a useful analytical tool.

In the model developed for the National Broadband Plan, a housing unit is determined to have "access to broadband capability" if it is located close enough to today's telephone or cable network infrastructure that it is technically feasible for a service provider to deliver broadband to those homes at actual speeds of 4 Mbps download and 1 Mbps upload today. Using that definition of access, the Plan estimates that 95% of the housing units in the U.S. can be served from today's infrastructure, meaning that at least 7 million U.S. housing units, or about 14 million Americans, cannot be served.

Just because a housing unit **can** be served, however, does not mean that it **is** served. There is no guarantee that a provider makes a retail service available to every home that its network is capable of serving. As a result, the actual number of citizens who cannot purchase broadband service is likely to be higher than 14 million.

Limitations in the data sources available to the FCC and used for the model also contribute to sensitivities in the estimate that 95% of U.S. housing units can be served with broadband today. For example, the cable industry data we used comes from Warren Media's Media Prints database, a public source that estimates 90% of housing units are reachable with cable-based broadband. This source attributes cable broadband availability to entire cable franchise service areas if any part of the franchise area is served with broadband. While this attribution is accurate in most cases, it is not accurate in all, and as a result the 90% figure may be an overstatement.

The Plan's estimate of an additional 5% of housing units reachable only through telephone-based broadband – typically Digital Subscriber Line (DSL) technology – is similarly based on limited data. The model relied on proprietary telephone network data that was available for a number of states, which we then used as an input to a statistical extrapolation technique (regression analysis) that allowed us to adapt the conclusions from these states to the rest of the nation. As is generally the case when statistical extrapolation techniques are used, the results are estimates rather than exact figures.

The broadband infrastructure deployment model developed for the Plan is not the only method the FCC is using to determine the size of the broadband deployment gap in the U.S. We also analyzed broadband subscribership data that we collect from service providers. Although analysis of broadband **subscribership** data is an imperfect means of assessing broadband **availability**, this analysis suggests that 92 percent of Americans live in areas where broadband service is offered, meaning that as many as 24 million Americans live in areas where broadband service is not offered.

While the results of this analysis are imperfect, they are, like the like the output of the Broadband Plan team model, a reasonable indicator of broadband availability. Based on these two methods of determining the size of the broadband deployment gap, we believe that broadband is unavailable to approximately 14 to 24 million Americans.

In addition to estimating the number of unserved housing units in the U.S., the model developed for the Plan also estimates the financial commitments needed to reach the unserved homes, and the likely revenues that would result for a commercial provider. This financial modeling showed us that for today's unserved homes, largely located in low-density rural areas, the private sector business case to reach them simply does not add up. While the market has done a great job of getting broadband to much of America, market incentives alone will not be enough to reach these remaining unserved homes. Just as the current Universal Service Fund was instrumental in ensuring the availability of telephone service to over 99% of Americans, so too will a financial commitment to universal broadband service be necessary to ensure that broadband availability surpasses

95% in the future.

It is also important to clarify that the 95% estimate refers to **availability** of broadband, not **adoption**. The Plan estimates the current adoption rate at 65%, meaning that 93 million Americans have chosen not to purchase broadband even if it is available to them. Cost, relevance, and digital literacy are important factors influencing those decisions. This is a different set of issues from those affecting the 14 to 24 million Americans for whom broadband is simply not available where they live, meaning that those who **want** to purchase broadband simply cannot.

The good news is that better data about broadband deployment is on the way. Two developments already in process should improve our ability to estimate more precisely the number and locations of Americans unserved with broadband. As a result of the Broadband Data Improvement Act, administered by the NTIA with technical assistance from the FCC, states are now gathering, primarily from industry, the first round of data that is specifically targeted at mapping broadband deployment. By next February, this data will have been integrated into the first national broadband map, which, as Congress directed, will be interactive and searchable.

In addition, later this year the FCC will propose revisions to its broadband data gathering to implement the Plan's recommendations regarding collecting a wider range of broadband data points so that questions about broadband availability can be answered more accurately in the future. We look forward to working with Congress, industry representatives, and public interest advocates to fashion a new regime of broadband data collection that will provide Congress and the FCC with the relevant data it needs to track progress, while respecting industry's concerns regarding data that is legitimately competitively sensitive.

When I served as a state commissioner, I learned that lack of broadband availability was the top constituent complaint to legislators from the rural and mountainous western portion of Massachusetts. And as Chief of the FCC's Wireline Bureau, far and away the most frequent correspondence I receive from members of this august body contains the same constituent complaint. The addresses are all over the country, but the issues are the same. In homes without broadband, children are at an educational disadvantage, parents are shut out from jobs that require online applications, and no one can access critical government information and services online. If you live in one of those homes, it may matter little to you whether broadband is available to 90, 92, or 95% of Americans. What matters most is that broadband is not available to 100% of the home you live in. And that is the problem that the National Broadband Plan is ultimately aimed at solving.

Thank you again for inviting me to testify and I will be happy to address any questions.

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Mr. BOUCHER. Thank you very much, Ms. Gillett. Mr. Villano.

STATEMENT OF DAVID VILLANO

Mr. VILLANO. Thank you. Chairman Boucher, Ranking Member Stearns, members of the committee, thank you for the opportunity to discuss the Department of Agriculture's broadband program, specifically USDA's Community Connect Grant Program, administered by our Rural Utilities Service. We appreciate the work and support you and members of Congress have provided to help build a strong, dependable and affordable broadband infrastructure in rural areas. Rural development is truly committed to the future of rural communities. Throughout my 33-year career with rural development, I have worked in virtually all the programs, including business, housing, community facilities, and most recently our Telecommunications Program.

My career began in the field and since coming to our national office in Washington, D.C., I have seen firsthand the tremendous impact that our investments made in rural communities. In my current position, I am responsible for all rural development telecommunication programs, and I can think of no program more fundamental to the future of rural America. The expansion of advance telecommunication network strengthens our nation's economy and its growth. Yet, in our rural communities internet use trails that of urban areas. At RUS, we view modern broadband infrastructure investment and rural economic competitiveness as a fundamental building block of sustaining economic development.

Communities lacking access to modern broadband service are at a severe disadvantage. During the past 60 years, RUS has provided nearly $19 billion in loans and grants to build communication infrastructure in rural communities across the United States. Since 1995, all RUS financed telecommunication facilities have been broadband capable. Our broadband loan program created by the 2002 Farm Bill has provided over $1.1 billion in loans to more than 90 broadband projects in rural communities spanning 42 states. Our distance learning and telemedicine program, also part of the 2002 Farm Bill, provides loans and grants for educational opportunities and health care services such as computer networks, telemedicine capabilities, electronic medical records, and interactive educational facilities to rural communities.

To date, our distance learning and telemedicine program have funded nearly 1,000 projects in over 40 states totaling $400 million. In 2009, the American Recovery and Reinvestment Act provided an additional $2.5 billion for broadband loans and grants. The Recovery Act allows USDA to provide a flexible mix of loans, grants, and loan-grant combinations similar to our water and community facility programs, which will make more project in unserved areas feasible and eligible for funding.

Our Community Connect grant program was created in 2002 to meet the needs of totally unserved areas. Community Connect provides grants to eligible applicants to establish broadband service on a community-oriented connectivity basis. Broadband service funded through the program must foster economic growth and deliver enhanced educational, health care, and public safety services. Community Connect has provided more than $98 million funds to provide broadband services in 197 unserved communities, including some of the lowest income, neediest, and often highest cost to serve areas in the nation. Twenty-five percent of them have gone to tribal areas. The demand for our Community Connect program has been considerable. Last year alone, RUS received over 200 applications requesting over $200 million for the $13 million that we had available.

An excellent example of the impact of the Community Connect program is the grant awarded to Sacred Wind Communications. This $436,000 Community Connect grant made in 2005 funded broadband service for the community of Huerfano, New Mexico, on the Navajo reservation. Today, Navajos of all ages come to the center to use the computers to check their e-mail, perform searches, job hunt, do homework assignments, play educational games, apply to college, and to meet with others for social and e-commerce business purposes. In October of 2009 American Express announced that Sacred Wind Communications was voted the most aspiring small business in America in the company's Shine a Light contest. This is but one example of how Community Connect serves a catalyst for sustainable broadband adoption in rural areas.

There is no single solution to the complicated mission of bringing advanced telecommunication services to every citizen. Government incentives, cost support mechanisms, changes in technology, and private investment all play a role. The $98 million invested through our Community Connect program is just one tool in the toolbox to achieve the Administration and Congress' broadband policy goals. As the most longstanding direct federal grant program to promote rural broadband Community Connect is worthy of further study to draw lessons learned, not only in terms of broadband deployment but in the impact on economic development, health care opportunities, education, and other key indicators of the vibrancy of local communities. These lessons can be applied to the analyst of much larger investments now being undertaken through the Recovery Act to promote broadband throughout the United States.

Rural communities will always face challenges in competing economically but they are stronger today because or the partnership forged at USDA's Rural Development. It is an honor and a privilege to work with you and our federal partners throughout the Obama Administration to make affordable broadband service widely available throughout rural America. Thank you again for inviting me here to testify. I will be glad to address any questions you may have.

[The prepared statement of Mr. Villano was unavailable at the time of printing.]

Mr. BOUCHER. Thank you very much, Mr. Villano. Mr. Garcia.

STATEMENT OF JOE GARCIA

Mr. GARCIA. Good morning. I am Joe Garcia, and I am the current chairman of the All Indian Pueblo Council in New Mexico, and also the vice president representing the National Congress of American Indians, also former president of the National Congress. Chairman Boucher, Ranking Member Stearns, and members of the committee, thank you for the opportunity to provide this testimony on the great potential of the National Broadband Plan to serve Indian country. Today, some 90 percent of Native Americans living in Indian country do not have affordable or reliable high speed access to the internet. The economic, cultural and human significance of that fact cannot be underestimated. Connecting Indian country with the world can reverse centuries of isolation and neglect.

In the National Broadband Plan, however, Indian country was not an afterthought. Concepts such as a tribal-centric deployment models and core community institutions are now becoming part of the FCC's vocabulary. The FCC now understands that carriers have often stopped at the borders of Indian country and why tribes often find themselves as the only ones willing to make the commitment to provide these services to their citizens. These lessons have taught us an important fact about telecom and Indian country. Deployment must be sustainable before it can ever hope to be profitable.

The submission of the plan to Congress is only the beginning of this process. This morning, I would like to highlight 5 recommendations. Our written testimony also expands beyond the comments here today. First and foremost, the plan recommends that Congress establish a tribal broadband fund to bring services to tribal headquarters and other anchor institutions, as well as assisting tribes in deployment planning, infrastructure build out, feasibility studies, technical assistance, business plan development and implementation, digital literacy, and outreach. Only a new separate fund will ensure that broadband is actually deployed in Indian country.

The existing BIP and the BTOP programs funded at $7.2 billion will not be sufficient to close the broadband availability gap. While a handful of tribal projects receive funding from the Recovery Act, it will take an additional $1.2 billion to $4.6 billion specifically targeted for the tribal broadband fund to begin to close the digital divide. Second, and equally important, is the creation of the FCC Office of Tribal Affairs. To be credible and effective, the FCC must give the office sufficient resources, authority, and jurisdiction over communication issues affecting Indian country. Congress must increase funding for the FCC's Indian telecom initiatives so that it can genuinely develop and drive a tribal agenda. This new office should be an effective instrument of the FCC and voice for tribal nations in Washington.

Third, the universal fund should be reformed with a special emphasis on the unique nature of Indian country. For instance, a library in Indian country may be different from what a library looks like elsewhere, but that is no reason to deny support. Indian schools need support not only for their classrooms but also for their dormitories where children need the internet to study. As sovereign nations, tribes need a seat at the table for ETC designations for USF support. In changing USF, however, Congress not inadvertently cut the only wire going into Indian country. The current analog telephone High Cost and Tribal Lifeline and Link-Up programs are vital to Indian Country and must not be negatively affected. To assist with this transition, we also urge Congress to establish a tribal seat on the USF Federal-State Joint Board.

Fourth, tribes need spectrum, spectrum that is often in the hands of licensees that have not used it to bring service to Indian country. The FCC should reclaim dormant spectrum and make it available to tribes who actually deliver services. This must be more than just unregulated or White Space spectrum. It must consider dormant licensed spectrum as well. Finally, we urge congressional support for the adoption of a Tribal Priority to address the many barriers to entry. The Tribal Priority that was recently adopted by the FCC for broadcast spectrum is well grounded in strong constitutional principles based on the political status of tribal nations as sovereign entities.

A new tribal priority should be used with reclaim spectrum to ensure that it is actually used for broadband services to tribal lands but it should also be used by the FCC beyond spectrum to barriers across the commission's rules. At this point, I would like to just say that at Ohkay Owingeh—Ohkay Owingeh is the Place of the Strong People. We live 25 miles from the state capital of New Mexico, Santa Fe. The Los Alamos National Lab, where I retired from, exists just 25 miles away, and yet our little community had no access to the internet. A phone company was there but it only brought DSL services, and my brother lived less than 1/8 mile away from where I lived. He had DSL. I didn't have DSL. But we took that opportunity to say we need access. And so we went and did a proposal to USDA some years ago. We got funded, and now we have wireless service in our community thanks to our own efforts and to the funding from USDA.

But that is really what life is about in this country is that if you live in the rural areas and remote areas that is where the non-access is the biggest culprit for America. While new congressional funding actions are essential, there will be a strong return on your investment by engaging tribal governments and community institutions, by taking a tribal-centric approach to deployment, by digging once and by sharing infrastructure efficiently. Federal funding will produce a bountiful return and will actually save money in the long run. In closing, there is one important benefit that I cannot fail to mention and that is the sense of empowerment that broadband can bring. The ability to shape one's own future to provide a better world for new generations is an important part of what we mean by tribal sovereignty.

The National Congress of American Indians looks forward to continuing our mutually beneficial relationship with the FCC and Congress as we all work to implement effectively the National Broadband Plan while finally moving Indian country to the forefront of technology. Thank you so much.

[The prepared statement of Mr. Garcia follows:]

UNITED STATES HOUSE OF REPRESENTATIVES SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY AND THE INTERNET

Hearing on -

"The National Broadband Plan:
Deploying Quality Broadband Services To The Last Mile"

Wednesday, April 21, 2010
2322 Rayburn House Office Building

Written Testimony of the
NATIONAL CONGRESS OF AMERICAN INDIANS
Embassy of Tribal Nations
1516 P Street, NW
Washington, DC 2005
202-466-7767

Good Morning. Chairman Boucher, Ranking Member Stearns, and Members of the Committee, thank you for the opportunity to provide this testimony on the impacts and potential of the National Broadband Plan (Plan) to serve Indian Country.

Today, approximately 90 percent of Native Americans living in Indian Country do not have high-speed access to the internet. The economic, cultural and human significance of that fact cannot be underestimated. Connecting Indian Country with the rest of the world can reverse centuries of isolation and neglect. The Plan supports tribal sovereignty and self-determination and empowers tribal nations to shape the future health and welfare of their communities with this critical infrastructure. Broadband has the great potential to empower tribes and their institutions in an unprecedented way, and afford Native American people and nations their rightful place in a world economy of ideas and opportunities. We applaud the FCC for recognizing this in its National Broadband Plan.

We believe that the FCC now has a better understanding of the needs and opportunities for Indian Country than at any time in recent memory. The priorities of Indian Country have been included in national communications policy in an unprecedented and meaningful manner. Concepts such as a "tribal-centric" deployment models and "core community institutions" are now becoming part of the Commission's vocabulary. The FCC now understands that traditional carriers, for whatever reason, have often stopped infrastructure deployment at the borders of Indian Country, regardless of whether those borders are in remote areas, or whether those borders are directly adjacent to highly populated areas. Tribal nations thus often find themselves as the only entity willing to make the commitment of resources and strategic planning to provide communications services to their citizens.

The FCC must ensure that the opportunity for tribal nations to deploy services in their own communities is developed and expanded in the new broadband mechanisms. The traditional model of telecommunications deployment in this country -- maximizing profits from residential customers that have driven urban and suburban build out -- simply does not work in rural America and especially does not work in Indian Country. Careful examination of successful models has proven that before tribal enterprises can become profitable, they first must become sustainable. Whether acting independently or in concert with a responsive industry partner tribal lands solutions are successful when the sovereign local knowledge base is involved. Tribal governments and core institutions, both tribal and federal, have to be engaged in the development, not just informed of it after the fact. This engagement must come from the FCC and other federal agencies in the form of consultation and coordination, and from the communications industries in the form of synchronized tribal-centric business planning. Indian Country knows that the incredible benefits of broadband will be achieved only through the genuine pursuit of these efforts.

The submission of the Plan to Congress is only the beginning of this process. For our purposes today, the Plan's recommendations fall into two categories: 1) Recommendations that require new statutory authority or funding from Congress; and 2) Recommendations the FCC and other agencies can implement under its own authority and without additional Congressional funding. NCAI and its partners, along with several tribal organizations participated heavily in the Plan docket and several of our recommendations were adopted by the FCC. The FCC listened closely to Indian Country and took action, and we now hope that Congress will listen closely and take action.

I. Recommendations that Require Additional Congressional Authority or Funding

In order to shift the paradigm of so little deployment on tribal lands, certain key recommendations will require new congressional funding. The single most important recommendation found within the National Broadband Plan with regard to all of Indian Country is the **Tribal Broadband Fund**. We do not support increased funding for its own sake, but do support funding that is targeted to:

- comprehensive infrastructure development deployment and planning;
- immediate-need Technical support and training to help tribes get their programs "shovel ready," and
- sustainable adoption of broadband and digital literacy in Indian Country.

As the Plan indicates in Section 8.4, the Tribal Broadband Fund should be created to support these and "a variety of purposes, including bringing high-end capacity connectivity to tribal headquarters or other anchor institutions, deployment planning, infrastructure build out, feasibility studies, technical assistance, business plan development and implementation, digital literacy and outreach", as well as "small, targeted grants on an expedited basis for Internet access and adoption programs." These many elements are the critical elements necessary to the future of broadband in Indian Country and without this new tribal broadband fund, that future will not be realized.

Only a new, separate fund will ensure that broadband is actually deployed in Indian Country. The National Broadband Plan notes, and the recent experiences of tribal nations demonstrates, that the existing Broadband Initiatives Program (BIP) and Broadband Technologies Opportunity Program (BTOP) at RUS and NTIA, funded at $7.2 billion, will not be sufficient to close the broadband availability gap. While a handful of tribal projects received funding from the Recovery Act, the record before the FCC reflects, and it is justifiable to expect, that it will take $1.2 to $4.6 billion, specifically targeted to the many purposes of the Tribal Broadband Fund. To be clear, these numbers assume the involvement of up to 25% of the tribal nations, so it is only enough to get a good start. These figures are sound estimates arrived at in coordination with the New America Foundation and backed up by on-the-ground numbers from actual successful wireless, fiber, and hybrid deployments among the tribal nations. This level of serious commitment is what it will take to close the infamous digital divide in Indian Country.

Further, it is very important that the FCC remain directly involved in the development of this fund. Only a flexible, "tribal-centric" planning approach to administering such a fund will allow it to succeed. The FCC must continue to consult with tribal nations and their institutions, and work with Congress, to refine this figure, develop proposed legislative provisions, and ensure the successful implementation of the Tribal Broadband Fund.

In order to take these steps, and several others, as recommended in Section 9.7 of the Plan, the FCC will create a new Office of Tribal Affairs. Long awaited, this development is quite welcome as the new Office is a necessary first step to coordinating on many tribal initiatives in the Plan. At its outset, the FCC must ensure the effectiveness of the Office of Tribal Affairs. It must be fully staffed and funded to deal with the many issues. To be credible and effective, the FCC must give the Office sufficient authority and jurisdiction over communications issues affecting Indian Country. To serve the Commission as a whole, and to coordinate effectively with tribal nations, other federal agencies, and the communications industries, it must be empowered, as the Plan states: "to develop and drive a tribal agenda in coordination with other FCC bureaus and offices and to manage the FCC-Tribal Broadband Task Force." If it becomes just another "Tribal desk" in another federal agency, it will not be an effective instrument of the FCC or voice for Native Americans in Washington.

Perhaps this is the second most important development in the Plan. Congress should do its part to ensure the effectiveness and future success of the new Office as well. It should provide additional funding to the FCC to support the efforts of the FCC's Office of Tribal Affairs as it will further develop and expand the FCC's Indian Telecommunications Initiatives. These Initiatives should become one of the responsibilities of the Office of Tribal Affairs. the Indian Telecommunications Initiatives can be developed beyond the routine workshops to envision increased direct, face-to-face consultation and diverse types of training opportunities through new methods of tribal outreach and coordination. Additionally, we support funding that will allow tribal representatives to participate in FCC University training programs, in order to acquire the expertise needed to thrive in a digital world.

Funding is necessary for broadband adoption and sustainability. Billions of dollars of infrastructure do little good unless the operation of these networks is sustainable. Indian Country needs more access to broadband. A study by Native Public Media and the New America Foundation, *"New Media, Technology and Internet Use in Indian Country,"* shows that Native Americans who have access to broadband use it, and use it in ways that urban and suburban residents couldn't imagine. But more Native Americans also need to understand the benefits that broadband brings: access to additional government services like education and health care, access to jobs, and access to new business opportunities that provide a real chance to end generational poverty and unemployment prevalent in Indian Country. Broadband means access to a new and better future.

Certain technical aspects of the Universal Service Fund should be reformed where congressional action is needed. The Schools and Libraries programs, for example, were designed without regard to what constitutes a "library" in Indian Country. Similarly, the current program has the unintended effect of allowing E-rate support for classrooms at Indian boarding schools, but not in dormitories, where children need access to the internet to study.

When Congress and the FCC consider an overhaul to the Universal Service Fund, they must carefully balance the old and the new. Because of the high cost of delivering broadband in Indian Country, coupled with high unemployment and poverty rates, broadband programs similar to the High Cost and Enhanced Tribal Lands Low Income Lifeline and Link-Up programs will need to be established. As this change occurs, however, Congress and the FCC must not inadvertently "cut the only wire" going into Indian Country. The current analog telephone High Cost and Lifeline and Link-Up programs are vital to Indian Country and must not be negatively affected. In regions of many different reservations, telephone penetration is still well below 50%. Simply eliminating current telephone programs to provide funding for broadband could widen the communications gap. To assist with this transition, and considering the unique needs of Indian Country, we support the FCC's recommendation that Congress amend the Communications Act, as part of its USF overhaul, to establish a tribal seat on the USF Federal-State Joint Board.

We also support the Plan's recommendation that Congress amend the Communications Act to allow anchor institutions on tribal lands to share broadband network capacity funded by the E-rate or the Rural Health Care program with other community institutions.

Additional funding, wholly separate from the Tribal Broadband Fund and directly in other agency budgets, is also needed to enable federal facilities in Indian Country to upgrade their connections. The Plan suggests that Congress appropriate $29 million to Indian Health Service for the purposes of upgrading its broadband service for Indian hospitals and telemedicine. Medical needs in Indian Country are great, and doctors are few. Telemedicine provides the hope that quality medical services can be made available to Native Americans, even those in the most remote reaches of America. Federal law enforcement and public safety on tribal lands faces similar dire challenges, exacerbated by interoperability needs.

Finally, there is also one other lesser-known federal program that is vital to communications needs in Indian Country. The Department of Commerce's Public Telecommunications Facilities Program (PTFP) is a matching-grant program that provides resources for public radio and television stations to invest in equipment. Again this year, the PTFP program has been zeroed out. Many tribes have been able to use PTFP funds to get new stations on the air or to replace aging equipment. These stations are incredibly important to listeners who do not have access to other sources of communications. Recently, new licensing windows have meant many new stations will be coming on line in Indian

Country. Importantly, these potential PTFP grantees represent media-related tribal anchor institutions that will play an important role in successful "tribal centric" broadband deployment planning and digital adoption. In a world of converging technologies, these stations and future broadband media entities are key in their diversity and localism. Congress should fully fund the PTFP program.

II. Recommendations the FCC and other Agencies Can Implement Now

NCAI supports a number of recommendations that the FCC can implement under current statutory authority. These recommendations include:

- **Establishing a Federal-Tribal Broadband Initiative** through which the federal government coordinates with tribal governments on broadband-related policies, programs and initiatives. This Initiative is in harmony with the Presidential Memorandum of November 5, 2009, in which President Obama called on all federal agencies to improve coordination with tribes. Efforts related to the Tribal Broadband Fund and many other issues, such as the Rights-of-Way Taskforce, will only flourish is properly coordinated.

- **Facilitating Tribal access to broadband funding opportunities**. The American Recovery and Reinvestment Act set forth laudatory community oriented goals of stimulating broadband deployment through the BTOP program at NTIA and the BIP program in the Rural Utilities Service. Unfortunately, relatively few American Indian and Alaska Native projects have been funded by these programs because the funding has been for applications of projects that were "shovel ready." This meant that the applicant had to have a small army of accountants and engineers to score high enough in the evaluation criteria to win an award for a project that could claim to be "shovel ready." More fundamental than this, the BIP and BTOP programs scoring criteria did not align with the situations in many parts of Indian Country.

The Department of Agriculture and RUS is to be congratulated for the changes it made in the course of the second round to make the BIP program more available to tribal nations. The Department of Commerce and NTIA should be recognized for its many efforts to coordinate and consult with tribes on proposed BTOP projects. However, for the vast majority of Indian Country, with certain important exceptions, timing and circumstances outweighed these opportunities.

In the future, these agencies will be able to seize upon the lessons learned about Indian Country within the tight deadlines and scoring methods of the Recovery Act programs. The Department of Agriculture should continue its consultations on its Significantly Underserved Trust Areas regulations to provide a tool to remove the barriers to entry within its own authorizing laws and regulations. Ultimately, the FCC, NTIA, and RUS need to provide planning grants or additional advance time and assistance to tribes, most of whom don't have the in-house expertise to prepare future BTOP and BIP like applications that compete against established telecommunications carriers.

- **Including Tribal governments in the decision-making process for modifying the Universal Service Fund**. Tribes should have a voice in revisions to the Universal Service Fund, especially in the area of Eligible Telecommunications Carrier (ETC) designation. Anytime Universal Service funding implicates tribal communities tribal governments and their institutions should be engaged in consultative dialogue. If a provider or carrier is seeking ETC status for tribal lands, this should necessitate the consultative involvement of the tribal nation being affected. Improved planning and deployment will result, and ultimately, the most effective use of Universal Service support should be the goal of all involved. To foster and increase the dialogue and knowledge of Indian Country in the administration of the Universal Service Fund. NCAI supports the FCC's establishment of a tribal seat on the USAC Board of Directors.

- **Recognizing and meeting the unique spectrum needs of Indian Country**. One area of the Plan where we feel the FCC's analysis and recommendations much reach further was in the area of access to spectrum in Indian Country. tribes need spectrum that is often in the hands of licensees that have not used it to bring service to Indian Country. The FCC should reclaim dormant spectrum and provide it directly to tribes, or to tribal-controlled entities who will actually deliver services. This effort must contemplate more than just unregulated or White Space spectrum, as the FCC recommends, but must consider dormant licensed spectrum as well. Economic development and community needs require robust long-term solutions and the growth of services that are also predicated on licensed spectrum.

  To this end, Indian Country needs a better "seat at the table" in the broadband mapping process. Tribes should be both contributors to the NTIA Broadband Mapping efforts in the near term and the FCC's "spectrum dashboard" program, but also have access to that data to corroborate and develop its accuracy. Far too often Indian Country has been "sold a bill of goods" when it comes to broadband – services that may theoretically be available, but in practice are denied to residents of Indian Country. Moreover, the speedometer of the "dashboard" must be accurate when it comes to services actually delivered to Indian Country. For those portions of Indian Country that do receive broadband, the actual throughput on many of these systems (especially satellite and shared wireless systems), is often far below the advertised speed. Congress and the FCC must invest the resources necessary to obtain an accurate map of true broadband capabilities in Indian Country.

- **The FCC should adopt a Tribal Priority policy to address barriers to entry in its regulations and policies,** similar to the Tribal Priority policy it has adopted for broadcast spectrum, and has indicated in the Plan that it will apply to non-broadcast spectrum. The Tribal Priority that was recently adopted for broadcast spectrum is well grounded in strong constitutional principles based on the political status and classification of Tribal nations as sovereign entities, rather than racial or ethnic preferences, and in a correspondingly strong and effective rational basis rules. For example, to the extent that the FCC determines that spectrum which could be used to deliver broadband to Indian Country has been warehoused or remains fallow, as described above, that spectrum should be reclaimed, and the Tribal Priority applied to ensure that that spectrum is actually used to deliver broadband services to tribal lands.

  This Tribal Priority rationale should be extended beyond the spectrum licensing arena at the FCC. The FCC should utilize all the constitutional legal tools it has to address the work it will do to bring broadband availability to Indian Country. Areas such as the Universal Service Fund could see successful development in such an approach, as they have before. In 2000, the Universal Service Fund rules for ETC designations and the low income Lifeline and Link-Up rules saw significant improvement and tribal communities saw the beneficial significant increase of telephone services increase when tribal specific rules, based on aspects of federal Indian law and policy, were developed. The Enhanced Tribal Lands Lifeline and Link-Up Program can be regarded as a significant pre-cursor to the FCC's much needed Tribal Priority approach.

The National Broadband Plan should be regarded as a timely investment in Indian Country. As stated above, the Tribal Broadband Fund, and other initiatives, will most likely and justifiably cost billions of dollars. However, this critically important funding will see an immediate return on investment and will actually save monetary costs in the long run through better pooling of broadband capacity across agencies.

While new Congressional funding and actions are essential, the forward coordination on many fronts will also ensure its effectiveness. By engaging tribal governments and their core community institutions, by taking a tribal-centric approach to deployment, by "digging once" and using infrastructure efficiently, federal funding will produce a bountiful return.

Another return on investment will be realized as well. This is found in the valuable lessons learned from the case studies of broadband deployments in Indian Country outlined in the above referenced NPM and NAF *New Media Study:* Tribal deployments not only spur economic development directly on reservations but also spur economic and business development on surrounding areas populated by both Native and non-Native Americans. Rather than broadband ending at the border of Indian Country, these deployments begin in Indian Country and then expand beyond reservation borders to enrich the lives of their neighboring communities in an entire region.

There is one important benefit that I cannot fail to mention, and that is the sense of empowerment that comes with surmounting technological barriers and harnessing the power of a communications medium. That sense of empowerment, the ability to shape one's own future to provide a better world for new generations, is an important part of what we mean by "Tribal Sovereignty."

The National Congress of American Indians looks forward to continuing our mutually beneficial relationship with the FCC and Congress as we all work to implement effectively the National Broadband Plan while finally moving Indian Country to the forefront of technology.

Attachment: Native Public Media and the New America Foundation, *"New Media, Technology and Internet Use in Indian Country"*

Mr. BOUCHER. Thank you, Mr. Garcia. Mr. Turner.

STATEMENT OF S. DEREK TURNER

Mr. TURNER. Chairman Boucher, Ranking Member Stearns, and members of the committee, I thank you for the opportunity to testify today on the important issue of the FCC's National Broadband Plan. I am the research director for Free Press, a public interest organization dedicated to public education and consumer advocacy on communications policy. We have for years worked to ensure that the principles and goals in the Communications Act are translated through the public policy process into a reality for all Americans. Thus, we welcome the call for the FCC to produce a National Broadband Plan and we were very pleased that Congress requested the plan contain an evaluation of the status of broadband deployment. Good data is a requirement for good policy, and as Congress has recognized for too long policymakers have not had the right data to understand the problems in our broadband market.

But as important as quality data is, it is equally important that the information be presented in a way where all the caveats, assumptions, and uncertainties are made extremely clear. Congress asked that the National Broadband Plan evaluate the status of broadband deployment and despite a valiant effort, I think that the information presented to Congress in the plan, particularly the way it is presented, overstates the actual availability of broadband service in America. In particular, the information presented in the plan serves to understate the magnitude of the underserved broadband problem, implying that high quality services are offered in most rural areas when we know that they probably are not. This is partly the result of some questionable assumptions that underlie the data but at a high level it is the result of an unfortunate presentation of the information that can be misleading.

The National Broadband Plan reports that 95 percent of U.S. housing units have access to broadband infrastructure capable of supporting actual download speeds of at least 4 megabits per second and actual upload speeds of at least 1 megabit per second, a service quality threshold which is the plan's national availability target. This finding is presented prominently in this map and the broadband plan, a figure with the title availability of 4 megabits per second capable broadband networks in the United States. Now when I hear the word availability or am told that something is available, I think that means that I could get the item or service because someone is offering it. But the plan's 95 percent available 4 megabit finding is not supported by data on what services are actually being offered.

The finding is largely based on the assumption that where cable services are such infrastructure is capable of delivering broadband service at this quality, but this is like saying if I build a grocery store on top of a mountain that is served by a forest road, bread is therefore available in my store because that forest road gives me the capability of bringing bread there. But if I had no bread on the shelf or if the bread is stale the customers won't much care that I have the capability of getting it there. The problems with this estimate only serve to highlight the fact that the FCC currently lacks adequate information on the actual state of broadband availability despite years of public and congressional pleas for better data. This need not be the case.

The commission has for nearly 2 years failed to act on its own proposal to collect broadband availability data and now despite the fact that the National Broadband Plan strongly recommends that the FCC finally gather this data, the commission has signaled its intent to delay the matter even further by starting another proceeding all the way at the end of this year. As I said at the start, good data is a requirement for good policy, but so too is a strong commitment to efficiency and good ideas in the face of entrenched interests. The National Broadband Plan does set out a plausible vision for modernizing the Universal Service Fund, one that Free Press generally supports. However, this USF transition plan still leaves in place many of the more problematic aspects of the existing subsidy system, including the lack of a determination of where subsidies are actually needed to keep rates at a quality and a reasonably comparable rate.

Also, the plan proposed to bring unserved areas 2010 era technology but not until 2020. This raises concerns whether these networks will be scalable to reach future universal service goals. If we follow such a path, we may ultimately end up just replacing one form of the digital divide with another where urban Americans have world-class quality networks while rural America is stuck with second class access. In closing, as Congress moves forward with the oversight of the National Broadband Plan and with its own ideas on universal service reform it should be aware of all the caveats in the data. Policymakers need the right information to ensure our broadband infrastructure challenges are met in the most efficient manner possible. I thank you for your attention and look forward to your questions.

[The prepared statement of Mr. Turner follows:]

MASSACHUSETTS
40 main st, suite 301
florence, ma 01062
tel 413.585.1533
fax 413.585.8904

WASHINGTON
501 third street nw, suite 875
washington, dc 20001
tel 202.265.1490
fax 202.265.1489

freepress
www.freepress.net

Testimony of

S. Derek Turner
Research Director
Free Press

before the

United States House of Representatives
Committee on Energy and Commerce
Subcommittee on Communications, Technology and the Internet

Regarding

The National Broadband Plan:
Deploying Quality Broadband Services To The Last Mile
April 21, 2010

Free Press
Massachusetts Office
40 Main St., Suite 301
Florence, MA 01061
(413) 585-1533

Free Press
Washington Office
501 3rd St, NW, Suite 875
Washington, DC 20001
(202) 265-1490

SUMMARY OF TESTIMONY OF S. DEREK TURNER, RESEARCH DIRECTOR, FREE PRESS

The FCC is poised to transition the existing Universal Service High Cost Fund to a Connect America Fund. This massive policy shift is the cornerstone of the Commission's National Broadband Plan and is the FCC's response to the Congressional directive for the agency to produce a plan that ensures "that all people of the United States have access to broadband capability." We commend the Commission for taking this significant first step toward making universal broadband a reality, but have several concerns about the details of the proposal. First and foremost, we have concerns about the assumptions that underlie the analytical foundation of this transition plan.

Congress requested that the National Broadband Plan contain "an evaluation of the status of deployment of broadband service," and the Plan reported back that 95 percent of U.S. housing units have access to broadband facilities capable of delivering at least 4 megabits per second (Mbps) in actual downstream speeds, and 1 Mbps in actual upstream speeds. However, the assumptions that underlie this assessment are quite suspect, and the figure itself likely overstates the true nature of broadband deployment in rural America. The estimate has five major underlying flaws: incorrect assumptions of full Internet service deployment within the cable TV service footprint; incorrect assumptions about the type of cable modem technologies deployed; predictions of DSL deployment based on existing state deployment maps that are perhaps flawed themselves; incorrect assumptions about the capabilities of deployed DSL facilities; and ignorance of middle-mile data transport constraints that may lead to an overstatement in the available quality of deployed last-mile facilities. Combined, these assumptions serve to understate the true nature of the underserved broadband problem, and if relied upon for long-term policymaking, may confound efforts to bring true high-quality services to every corner of the Union.

The problems with this estimate only serve to highlight the fact that the FCC currently lacks adequate information on the actual state of broadband availability, despite years of public and Congressional pleas for better data. This need not be the case. The Commission has for nearly two years failed to act on its own proposal to collect broadband availability data. And now, despite the fact that the National Broadband Plan strongly recommends that the FCC finally gather this availability data, the Commission has signaled its intent to delay the matter even further.

Good data is requirement for good policy, as is a strong commitment to efficiency and good ideas in the face of entrenched interests. The National Broadband Plan does set out a plausible vision for modernizing the old USF to ensure universal access to current-generation quality broadband services. However, the transition plan still leaves in place many of the more problematic aspects of the existing subsidy system, including the lack of a determination of where subsidies are actually needed in order to keep rates and service quality reasonably comparable to rates and quality in urban areas. Further, the transition plan maintains the existing regulatory support structure, where carriers are reimbursed based on their total network cost minus any regulated revenues. This support structure fails to recognize that the high revenue earning potential of *existing* rural broadband networks may lessen the need for ongoing subsidy support. The transition plan also appears to adopt a path that brings unserved areas up to par with 2010-era technology, but not until 2020. This raises concerns whether these networks will be scalable to reach future universalization goals. If we follow such a path, we may ultimately end up just replacing one form of the rural-urban digital divide with another.

As Congress moves forward with oversight of the National Broadband Plan and with its own ideas on universal service reform, it must be aware that despite the efforts of the Omnibus Broadband Initiative, we still don't have all the facts in. It is now critical that the FCC act immediately to collect the data that it and other policymakers need to ensure our broadband infrastructure challenges are met in the most efficient manner possible.

Introduction:
Addressing Our Broadband Infrastructure Challenges Requires Good Data and Good Ideas

In the American Recovery and Reinvestment Act Congress asked the Federal Communications Commission (FCC) to produce a plan to "ensure that all people of the United States have access to broadband capability" with a strategy for achieving "affordability… and maximum utilization of broadband infrastructure" by the public. To this end, the FCC's National Broadband Plan takes a first step toward a larger reshaping of the policy framework governing broadband networks by embracing the idea that broadband Internet access is no longer simply an entertainment service. Rather, it is rapidly becoming critical infrastructure for the 21st century, as the telephone network was to the 20th century.

The core of the National Broadband Plan is the proposal to transition the existing Universal Service High Cost Fund to a Connect America Fund. We commend the Commission for taking this significant first step toward bringing broadband service to all Americans, but have several concerns about the proposal. First and foremost, we have concerns about the assumptions that underlie the analytical foundation of this transition plan.

In asking for a national broadband plan, Congress emphasized the need for the resulting policy framework to be based on good data. Congress asked the FCC to deliver "an evaluation of the status of deployment of broadband service." To meet this directive, the National Broadband Plan reports that 95 percent of U.S. housing units have access to broadband facilities capable of delivering at least 4 megabits per second (Mbps) in actual downstream speeds, and 1 Mbps in actual upstream speeds. If true, this would mean that our broadband infrastructure challenges are far more manageable than previously thought.

However, upon close examination, it is quite apparent that this determination of broadband deployment is built upon a house-of-cards of assumptions, each deeply flawed in its own right. The result is a certain overstatement of the level of broadband deployment. The simple fact is the FCC currently lacks adequate information on the actual state of broadband availability, something the Broadband Plan itself recognizes. This is rather unfortunate, because the Commission has for nearly two years failed to act on its own proposal to collect broadband availability data -- a proposal that has widespread industry and consumer group support. Unfortunately, despite the National Broadband Plan's emphasis on the need for the FCC to gather better availability data, the Commission is now poised to delay the matter even further.

Good data is requirement for good policy. But so too is a commitment to efficiency and good ideas in the face of path dependence. The National Broadband Plan sets out a plausible vision for transitioning the old USF to a new broadband-centric universal service system. However, the transition plan still leaves in place many of the more problematic aspects of the existing subsidy system, including the lack of a determination of where subsidies are actually needed in order to keep rates and service quality reasonably comparable to rates and quality in urban areas.

Further, the transition plan maintains the existing regulatory support structure, where carriers are reimbursed based on their total network cost minus any regulated revenues. This support structure fails to recognize that the high revenue earning potential of *existing* rural broadband networks may lessen the need for ongoing subsidy support. The transition plan is also vague as to what quality of networks will be supported, but it appears the calculations are largely based on the cost to upgrade or extend existing infrastructure to offer the 4Mbps/1Mbps standard of service. While this option may require fewer expenditures in the short-term, it raises concerns whether these networks will be scalable to reach future universalization goals. We may ultimately end up just replacing one form of the rural-urban digital divide with another.

As Congress moves forward with oversight of the National Broadband Plan and with its own ideas on universal service reform, it must be aware that despite the efforts of the Omnibus Broadband Initiative, we still don't have all the facts in. Though we may have had to put the subsidy cart before the data horse in the case of the BTOP and BIP stimulus programs, it is now critical that the FCC act immediately to collect the data that it and other policymakers need to ensure our broadband infrastructure challenges are met in the most efficient manner possible.

The National Broadband Plan's Assessment of The State of Broadband Deployment Appears to be Flawed, Overstating the Availability of Quality Broadband Services

The National Broadband Plan ("NBP" or "the Plan") sets an initial "universalization target" of 4 Mbps of actual download speed and 1 Mbps of actual upload speed, which it describes a target representative of "a speed comparable to what the typical broadband subscriber receives today."[1] In other words, the NBP sets a *floor* of 4 Mbps/1 Mbps, based on what the *median* actual speed of U.S. connections are today.[2] With this "universalization target" in mind, the Plan then proceeds to determine that infrastructure capable of delivering this target is currently available in 95 percent of U.S. housing units.[3]

Put mildly, this claim is astounding to many of those who have observed and studied the U.S. broadband market. Unfortunately this claim, which differs wildly from the conventional wisdom of the state of the broadband market, is not in any way backed up in the National Broadband Plan with the kind of exhaustive documentation needed to support such an estimate. Aside from some minor explanation in the footnotes, the NBP merely cites a "forthcoming" study that will supposedly provide support to this sweeping assertion. Yet, as of a month after the release of the National Broadband Plan, this study has yet to be made publicly available.

However, we do know enough about how the FCC calculated this 95 percent figure to cast serious doubt on its validity. The Plan's availability estimate suffers from five major flaws:

Flaw #1 - The estimate assumes full deployment of broadband services within the cable television system footprint. The estimate is primarily based on the knowledge of where cable modem services are available, but the Commission lacks such specific knowledge. Instead, they appear to have information as to the geography of cable television franchise areas, then assume that wherever cable TV is available, so too is cable modem service. But the available evidence does not support this assumption of full deployment within the cable footprint.[4]

Flaw #2 - The estimate assumes the "DOCSIS 2.0" technology is fully deployed throughout the entire cable television system footprint. This is an important assumption, because it is required in order to meet the universalization target's upload threshold of 1 Mbps.[5] But contrary to the NBP's assumption, there is no evidence that DOCSIS 2.0 has been universally deployed, and substantial anecdotal evidence to suggest that many cable systems still rely on the older technology standard.[6]

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[1] *See* "Connecting America: The National Broadband Plan," Federal Communications Commission, Omnibus Broadband Initiative (OBI), March 2010, at page 135 (*hereafter "the Plan" or "NBP"*).

[2] *See NBP*, at page 156. The 4 Mbps/1 Mbps target is based on what the NBP predicts will be the median U.S. actual speed at the end of 2010. It is not the median *deployed* speed.

[3] *See NBP*, at p. 157, noting (quoting the Census Bureau), "Housing units are distinct from households. 'A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.' In contrast, 'A household includes all the persons who occupy a housing unit. . . . The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements." There are 130.1 million housing units and 118.0 million households in the United States."

[4] For example, the National Cable and Telecommunications Association (NCTA) reports that currently, cable modem services are available to 96.7 percent of homes in the cable footprint. *See* http://www.ncta.com/Statistics.aspx (showing that 121.9 million of the 126 million homes passed by cable are served with some form of cable modem service. Note that the NCTA reports cable modem is available to 92 percent of U.S. households, though this is not the same as "housing units", the metric chosen by the NBP, and does not reflect the quality of cable modem service available to those households).

[5] DOCSIS, or "Data Over Cable Service Interface Specification," is a telecommunications standard that facilitates of high-speed two-way data transfer over the existing coaxial cable television system. The DOCSIS 1.1 standard enables a total of 38 Mbps downstream capacity and 9 Mbps upstream capacity (excluding overhead), shared amongst an entire neighborhood or system node. DOCSIS 2.0 enables greater upstream capacity (27 Mbps), and has permitted operators to offer advertised upstream speeds that are typically in the 2 to 10 Mbps range. Systems using the DOCSIS 1.x standards have very limited upstream capacity, and in practical deployment, offer upstream capacities in the 384 kilobits per second (kbps) to 896 kbps range.

[6] *See* "Better Returns from the Return Path: Implementing an Economical Migration Plan for Increasing Upstream Capacity," Motorola (2008).

Flaw #3 - The NBP's estimate of 95 percent 4 Mbps/1 Mbps availability is also based on where DSL services are available outside the cable footprint (since the estimate assumes 100 percent deployment of 4 Mbps/1 Mbps minimum cable modem services within the cable footprint). But the estimates of DSL deployment are even more speculative than the cable modem estimates. The OBI created an econometric tool to estimate where DSL services are likely to be available based on input from prior state-based broadband mapping efforts. But many of these maps come with their own sets of assumptions and limitations, and have been roundly criticized.[7] To use these state-based maps as the sole input to estimating where DSL services are nationwide is an acceptable predictive method absent other data, but it is one that should come with adequate warnings about the degree of uncertainty and appropriateness of interpretation. As the old saying goes, "garbage in, garbage out."

Flaw #4 - The NBP's estimate of 95 percent 4 Mbps/1 Mbps availability vastly overstates the availability of DSL services available outside of the cable footprint that are capable of achieving these speed thresholds. Notably, the vast majority of residential DSL service deployments in the U.S. are not capable of delivering upload speeds that exceed 1 Mbps, as these services typically max out at 896 kbps.[8] Further, while DSL infrastructure capable of maximum 7.1 Mbps theoretical downstream speeds are commonly available in many urban areas, DSL of the 1.5-3.0 Mbps maximum download variety is still common throughout rural service areas, due to the distance limitations of the technology.[9]

Flaw #5 - The NBP's estimate of 95 percent 4 Mbps/1 Mbps availability assumes the universal availability of "middle-mile" backhaul capacity needed to enable last-mile ISPs to offer services at this quality level. This assumption frankly contradicts other findings in the NBP itself, as well as the large record on this issue.[10] This assumption is critical to the overall finding, because much of the availability in rural America assumed in the NBP is dependent on cable modem services. Cable modem is certainly a robust technology that is cable of delivering speeds well in excess of the NBP's universalization target, but only in the last mile. If there is not adequate middle mile capacity, the assumptions made about cable modem deployment in the NBP are inherently suspect. Indeed, the American Cable Association, which represents small cable operators, has stated that "many [cable companies] have sufficiently funded 'last mile' projects on their own, but are unable to provide faster broadband speeds because they lack access to high capacity 'middle mile' facilities."[11]

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[7] *See* e.g. Further Comments and Further Reply Comments of Consumers Union, Consumer Federation of America, Free Press and Public Knowledge, *In the Matter of Development of Nationwide Broadband Data to Evaluate Reasonable and Timely Deployment of Advanced Services to All Americans, Improvement of Wireless Broadband Subscribership Data, and Development of Data on Interconnected Voice over Internet Protocol (VoIP) Subscribership*, WC Docket No. 07-38, filed June and September 2008.

[8] The NBP estimates do appear to account for DSL distance limitations, inferring that housing units less than 12,000 feet from a DSLAM can achieve the universalization target, while homes between 12,000 and 16,000 feet from the DSLAM can achieve less than the target, but more than 768 kbps downstream (the theoretical limit for 2 Mbps ADSL is 16,000 feet, while the limit for 8 Mbps is 9,000 feet). But these estimates *ignore* the fact that ADSL's theoretical upstream capabilities top out just above 1Mbps, under ideal short loop situations, ignoring any data overhead. This is true for the more advanced standard of DSL (ADSL2+) used in deployments by AT&T, CenturyLink and others that enable much higher download speeds. Thus it is unlikely that *any* of the DSL lines identified as lying outside the cable footprint are capable of actually delivering 1 Mbps upstream capacity. *See* http://www.dslreports.com/distance, http://www.itu.int/rec/T-REC-G.992.1/en and http://www.itu.int/rec/T-REC-G.993.1-200406-I/en.

[9] According to the National Telecommunications Cooperative Associations' latest annual survey of members, "forty-six percent [of respondents] indicated that the average distance from the digital loop carrier (DLC) to the end user was between 15 and 18 thousand feet (kft), 24% between 9 and 15 kft, 22% greater than 18 kft and 8% 9 kft or less." *See* "NTCA 2009 Broadband/Internet Availability Survey Report," National Telecommunications Cooperative Association, October 2009.

[10] *See generally* comments filed *In the Matter of Impact of Middle and Second Mile Access on Broadband Availability and Development*, NBP Public Notice #11, GN Docket Nos. 09-47, 09-51, 09-13, Public Notice, 24 FCC Rcd 12470 (2009).

[11] *See* Comments of The American Cable Association, In the Matter of the American Recovery and Reinvestment Act of 2009 Broadband Initiatives, Docket No. 090309298-9299-01, April 13, 2009 (*ACA NTIA Comments*). Available at http://www.ntia.doc.gov/broadbandgrants/comments/7DB6.pdf.

Though the FCC Claims it is Now A "Data-Driven" Agency, It Continues to Ignore the Need to Collect Critical Data Essential to Formulating Sound Universal Service Policies

The flaws in the National Broadband Plan's estimates of the scope of the un- and underserved broadband problem is just one more example of the agency's failings when it comes to data collection and analysis. Though the Commission has made improvements in recent years, and though the NBP charts a path for further improvement, we have yet to see the FCC take the steps necessary to improve its data collection and analysis practices. This is unacceptable, especially given that these issues have been well-known to the Commission for many years.

The ARRA asked the FCC to deliver "an evaluation of the status of deployment of broadband service" and tasked the NTIA with developing "a comprehensive nationwide inventory map of existing broadband service capability and availability in the United States that depicts the geographic extent to which broadband service capability is deployed and available from a commercial provider or public provider throughout each State." Congress clearly recognized the need to understand the scope of broadband availability, and given the passage of the Broadband Data Improvement Act the year prior, was perhaps a bit frustrated that such knowledge did not exist at the FCC and Department of Commerce.

This frustration is well placed. Though the FCC has been collecting broadband data from ISPs for over a decade, it has yet to ask providers to submit information about the availability and capacities of their services. In 2007 the FCC began a process to correct this deficiency, and issued long-awaited changes to the *subscribership* information collected from ISPs. In 2008, following from this effort, the FCC reached a tentative conclusion on the issue of broadband availability data, with a commitment to a rule by the end of that year. Free Press worked with other stakeholders to reach agreement on some of the issues with the FCC's tentative conclusions that caused concern among certain ISPs. We along with AT&T reached consensus on a census-block based methodology for collecting availability data, one that would provide very granular deployment information without placing too heavy of a reporting burden on ISPs. Unfortunately, the FCC failed to act on this issue prior to the departure of Chairman Kevin Martin.

However, we once again raised this issue before the Commission, bringing to the attention of the staff of acting Chairman Copps on multiple occasions in early 2009.[12] We noted how quick action on the issue of availability data would help guarantee the efficiency and likely success of the pending broadband stimulus efforts at the NTIA and RUS. The Commission did not act.

In July of 2009, we once again raised the issue before the staff of newly sworn in Chairman Genachowski.[13] In a detailed presentation, we noted how swift FCC action could enable the NTIA to save potentially hundreds of millions of dollars that it was poised to spend on state-based mapping efforts. The FCC again failed to act, though NTIA did ultimately implement our recommendation to move to a census-block unit of reporting, which was agreed to by most of the major U.S. ISPs and their trade associations.[14] Having failed to convince the Commission to act on the availability data issue in time to influence the NTIA's own efforts, Free Press along with five other public interest organizations sent Chairman Genachowski a letter in August of 2009, expressing the pressing need to collect such information as soon as possible in order to put the National Broadband Plan on sound analytical footing.

These past pleas for the Commission to bring its broadband availability data collection proceeding to a resolution have gone ignored. However, the National Broadband Plan itself does recognize the need to collect this information, recommending that the FCC "collect broadband availability data at the census block level, by provider, technology and offered speed." By reading the NBP, one can infer that the Omnibus Broadband Initiative (OBI) team felt that the lack of such information would be an impediment to successful policymaking, and that collecting such information should be a Commission priority. Unfortunately, the FCC doesn't appear to agree. In its proposed 2010 schedule for Broadband Plan Implementation, the Commission

[12] *See* ex parte letters filed by Free Press in 07-38 on February 3, February 6, and March 6 2009.

[13] *See* ex parte letter filed by Free Press in 07-38 on July 7, February 6, and March 6 2009.

[14] *See* Fawn Johnson, "Commerce Dept Drops Request for Sensitive Telecom Data", *Dow Jones Newswires*, August 7, 2009.

proposes to *begin* a new proceeding on the issue of broadband data -- in the forth quarter of this year. Given past history, this likely means that any broadband availability data will not be collected and analyzed until perhaps the first few months of 2014.[15]

Thus, even though there is widespread agreement among consumer groups, state regulators and industry on what types of availability data should be collected, and even though the Commission has already conducted a proceeding on this issue and come to a reasonable tentative conclusion that is endorsed by the National Broadband Plan itself, the FCC proposes to *start over* on this issue, *at the end of this year* no less. This, to put it mildly, is simply stunning, and it raises serious questions about the FCC's commitment to sound, fact-based, data-driven policy making, despite numerous assurances by the Chairman to the contrary.[16]

But the fact that the FCC is poised to move forward with its universal service transition plan absent adequate data is perhaps just more of the same for this subsidy program. As the GAO has noted,[17] the FCC has yet to ask and answer the critical question: what subsidies are needed to ensure the desired outcomes are met? The USF simply lacks a mechanism to determine what level of subsidy is needed to ensure that voice services are available at reasonable comparable price and quality. In this light, the NBP's estimate that 95 percent of the country's housing units can receive 4 Mbps/1 Mbps quality broadband services, most likely made available by completely unsubsidized cable companies raises a very interesting question about the need for the existing telephony USF. If only 7 million housing units lack access to this capacity, what is the exact need for the existing USF, which provides support for over 20 million lines operated by small LECs alone, and support for the loop cost of another 10-million plus lines operated by larger non-rural ILECs?[18]

In other words if cable companies are operating unsubsidized in areas of subsidized ILECs and CETCs, and able to offer reasonably priced voice services, why do we continue to subsidize those ILECs and CETCs? Yes, it is true that the LECs have Carrier of Last Resort (COLR) obligations, but there is no reason why those obligations could not be placed on the cable carrier. The point of universal service as established in Section 254 of the Act is not to ensure universal availability of LEC-offered voice services, but to just ensure such services are available at reasonable quality and rates. In many respects, the Act's goal of a competitive voice services market has been reached, but the FCC's USF program simply fails to account for this. Thus, in addition to the need to collect better broadband deployment data, the FCC needs to gather better information that will enable it to more wisely spend ratepayer funds as it conducts the slow transition of the USF from a voice-centric to data-centric fund.

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[15] The Commission last began a proceeding to make changes to Form 477 in the summer of 2007. The first report containing information from that effort was just released this March. Thus, it took nearly 3 years from the time the proceeding began, to the time the first analysis was released.

[16] *See e.g.* Statement of Julius Genachowski, Nominee to Serve as Chairman of the Federal Communications Commission, Before the U.S. Senate Committee on Commerce, Science, and Transportation, June 16, 2009. ("My career inside and outside government has convinced me that the FCC can be a model for excellence in government, fighting for consumers and families, fostering investment and innovation, through open, fair, and data-driven processes -- a 21st century agency for the information age."); Remarks of Chairman Julius Genachowski to the Staff of the Federal Communications Commission, June 30, 2009. ("Our policy decisions will be fact-based and data-driven."); Chairman Julius Genachowski, Prepared Remarks on National Broadband Plan Process, FCC Open Meeting, July 2, 2009. ("I am pleased that we have a plan that will be data-driven. That means not starting with conclusions, but using data to develop analysis. It also means not just accepting data, but digging into data, to find concrete solutions that supersede ideology -- and that can make a difference in the lives of real Americans.")

[17] *See* "FCC Needs to Improve Performance Management and Strengthen Oversight of the High-Cost Program," United States Government Accountability Office, GAO-08-633, June 2008. "[P]rior GAO reports indicate that best practices include developing goals and measures that address important dimensions of program performance, developing intermediate goals and measures, and developing goals to address mission-critical management problems. Yet, FCC has not established long-term or intermediate performance goals and measures. Additionally, OMB noted that performance measures should reflect desired outcomes, which describe the intended results of the program. Yet, FCC data collection efforts focus on program outputs, such as the number of requests for support payments, which describe the level of activity. In the absence of program goals, measures, and data about the program's performance, the Congress and FCC may be limited in their ability to make informed decisions about the program's future."

[18] Carriers classified as "rural" for the purpose of the USF receive support for approximately 20 million lines through the various rural support programs (HCL, SNA, SVS, LSS, ICLS). The High Cost Model provides support for loops of another 11 million lines owned by "non-rural" ILECs.

The National Broadband Plan's "Universalization Target" Ignores the Standard for Broadband That Congress Set out in the Telecommunications Act of 1996, and Re-affirmed in the 2008 Farm Bill

The National Broadband Plan picked the 4 Mbps/1 Mbps universalization target based on what the typical U.S. consumer receives today. But it isn't clear on why the FCC decided to settle for the status quo in setting its universalization target, nor is it clear why the Commission chose an asymmetrical threshold which runs counter to the standard for broadband that Congress has previously enumerated.

Though the term "broadband" is used 48 times in the American Recovery and Reinvestment Act the legislation did not explicitly define "broadband." There are only two explicit examples of a legal definition of the term broadband in the law.[19] The first is found within the Telecommunications Act of 1996. In defining the term "advanced telecommunications capability" in Section 706 of the Act, Congress stated that:

> "The term 'advanced telecommunications capability' is defined, without regard to any transmission media or technology, as high-speed, switched, *broadband* telecommunications capability that enables users to *originate and receive high-quality voice, data, graphics, and video* telecommunications using any technology" (*emphasis added*).[20]

The second example is found within the Food, Conservation, and Energy Act of 2008, which amended the Rural Electrification Act of 1936.[21] This law defined the term "broadband service" by stating:

> "The term 'broadband service' means any technology identified by the Secretary as having the capacity to transmit data to enable a subscriber to the service to *originate and receive high-quality voice, data, graphics, and video*" (*emphasis added*).[22]

The above two definitions were written a dozen years apart, but are virtually identical. From these legal definitions, we see Congress clearly views broadband as a technology that is characterized by the ability to allow users (or "subscribers") to engage in high-quality multi-media *two-way* communications. Therefore, for the purposes of implementing the National Broadband Plan, the Commission should have established thresholds that at a minimum adhere to the definitional standards set in 1996 Telecom Act and the 2008 Farm Bill.

In other words, if the Commission chooses to formalize a definition of broadband, it must look at the applications that a particular technology enables end-users to utilize. Based on the legislative language of "originate and receive" and "high-quality video", we feel that at a *minimum*, the floor of the FCC's broadband universalization target should be defined as a symmetrical telecommunications service that can reasonably deliver 5 Mbps of bandwidth, in both the down and upstream directions, at latencies low enough to enable high-quality real time voice and video two-way communications.[23] The NBP's 1 Mbps upstream standard cannot be defended based on faithful interpretation of the law, because this is simply not enough capacity to originate high quality video.

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[19] Only 29 enrolled bills enacted by the House and the Senate contains the term "broadband." Of these 29, only the 1996 Telecom Act and the 2008 Farm Bill deals directly with the broadband definitional issue.

[20] Public Law 104-104, Section 706(c).

[21] Public Law 110-246, commonly known as the "2008 Farm Bill". Congress passed H.R. 2419 by overriding a Presidential veto, but had inadvertently excluded a title from the enrolled bill. To account for this error, both chambers re-passed the farm bill conference agreement as H.R. 6124.

[22] 7 U.S.C. 950bb. Public Law 110-246 amended Section 601 of the Rural Electrification Act of 1936 to reflect this definition of broadband service.

[23] This standard reflects the bandwidth and latencies currently required to engage in a two-way video communications with a vertical resolution of 720 non-interlaced pixels and a scan rate of 24 frames per second, utilizing the current most-efficient compression technology -- the MPEG-4 codec. However, we must emphasize that the FCC's goals and targets, especially those dealing with "reasonably comparable service" definitions in the context of USF need to be symmetrical. What we are suggesting is the *floor* must be 5 Mbps downstream, 5 Mbps upstream in order to be in line with the definitions in the 1996 Act and the 2008 Farm Bill. But if the FCC finds that the typical downstream speed available in urban areas is say, 10 Mpbs, then a "reasonably comparable" standard for the purposes of USF could have a 10 Mpbs downstream, 5 Mbps upstream definition. *See* Comments of Free Press in NBP Public Notice #1, August 31, 2009.

THE NATIONAL BROADBAND PLAN'S USF TRANSITION PROPOSAL: A GOOD START, BUT THERE IS MUCH MORE WORK TO DO

The communications industry is characterized by economies of density, scale, and scope. Communications networks infrastructure often is more expensive to deploy and maintain in geographically sparse rural areas, but such deployments will reap greater returns if they are carried out on a larger scale and if the networks are capable of offering multiple types of services. In the Telecommunications Act of 1996, Congress directed the FCC to establish a subsidy system to ensure that consumers in all regions of the nation have access to basic telephone service and also directed the Commission to modernize the program to account for advances in communications technologies.

While the Universal Service High Cost Fund has been very successful in promoting the universal availability of basic telephone service, the Commission has yet to follow through on calls to modernize the fund by expanding support to rural broadband networks. Also, critics note that the current High Cost Fund is structured in a manner that has led to explosive growth in the overall size of the fund (tripling over the last decade) without any corresponding accountability regarding the actual need and impact of existing subsidies. Simply modernizing the fund by adding broadband to the existing fund will add further weight to an already strained and potentially unsustainable subsidy system.

In the ARRA, Congress requested that the FCC produce a plan that ensured that "all people of the United States have access to broadband capability." To this end, the National Broadband Plan proposes to transition the existing Universal Service High Cost Fund to a Connect America Fund. We are very encouraged that the Commission recognized the need to not merely add broadband to the list of supported services, but the need to modernize the Fund by transitioning the Fund. The proposal outlined in the NBP is the first significant step toward bringing broadband service to all Americans, but there is a tough road ahead, and the Commission's work -- particularly their analytical and planning work has only just begun. The general transition framework discussed in the NBP is a start, but going forward the Commission must focus on two areas overlooked in the proposal: the need to reform the inefficiencies of the old system during the transition, and the need to plan for future-proof deployment.

The Plan indicates that there are seven million U.S. housing units that have yet to see broadband deployment, and calculates that providing access to 6.75 million of these units will require approximately $11 billion in subsidies over a 10-year period. The Plan concludes that about half of the unserved housing units will only require initial capital deployment cost subsidies, while the remaining areas will require both capital and ongoing cost support.[24] To fund the extension of broadband to these areas, the Plan establishes the Connect America Fund (CAF), and establishes a transition plan to move the legacy telephony subsidy system to an all-broadband support system over a 10-year period. During this 10-year period, the CAF will fund deployment and ongoing support to unserved areas, funded via a reallocation of USF monies away from mobile wireless telephony carriers,[25] as well as by reducing certain payments to small rural phone companies[26]

[24] While we are deeply skeptical of the NBPs assessment of the availability of 4 Mbps/1 Mbps services, we do concur that the number of completely unserved occupied households (as opposed to un- and underserved) is likely in the 7 to 9 million range. Where we are skeptical is the NBP's assessment that *all* the remaining homes have access to broadband at the 4 Mbps/1 Mbps level. While we have no precise information, due to middle-mile limitations and the continued reliance on DOCSIS 1.1 technology, it is likely that the size of this "underserved" problem is as big as the unserved problem. But again, until the FCC moves to collect better data, we simply cannot define the scope of the underserved problem with any degree of certainty.

[25] The Plan envisions freeing up $3.9 billion by 2020 from zeroing out High Cost Fund payments to Sprint and Verizon Wireless (pursuant to prior commitments) and freeing up an additional $5.8 billion by 2020 by phasing out all support for Competitive Eligible Telecommunications Carriers, who are for the most part wireless providers offering services in areas also served by a wireline telephone company.

[26] The Plan envisions capping payments to rural rate of return carriers from the Interstate Common Line Support fund, which is designed to ensure these carriers earn their 11.25 percent rate of return. This effectively makes these carriers move to price cap regulation, and is estimated to free up an additional $1.8 billion by 2020.

and larger phone companies.[27] Through this reallocation process, the Plan estimates it will free up $15.5 billion, $4 billion of which will be used to fund deployment of 3G mobile networks in the few states that lag the national deployment level, with the remaining $11.5 billion allocated to the CAF.

The Plan sets out a plausible vision for transitioning the old USF to a new broadband-centric universal service system. However, the transition plan still leaves in place many of the more problematic aspects of the existing subsidy system, including the lack of a determination of where subsidies are actually needed in order to keep rates and service quality reasonably comparable to rates and quality in urban areas.

Notably, during the transition, the plan maintains the existing regulatory support structure, where carriers are reimbursed based on their total network cost minus any regulated revenues. This support structure fails to recognize that the high revenue earning potential of existing rural broadband networks may lessen the need for ongoing subsidy support. The transition plan is also vague as to what quality of networks will be supported, but it appears the calculations are largely based on the cost to upgrade or extend existing infrastructure to offer the 4Mbps/1Mbps standard of service. While this option may require fewer expenditures in the short-term, it raises concerns whether these networks will be scalable to reach future universalization goals.

But at this stage, the transition plan is little more than a concept, one that will be fully fleshed out as the Commission moves forward with the Notice of Proposed Rulemaking (NRPM) process, which the FCC is slated to launch on April 22nd. We look forward to offering detailed analysis during the USF transition NPRM process. We hope the NPRM will confront the unanswered questions and contemplate alternate transition paths, such as those offered to the Commission during the 2006-2008 proceedings on this issue.

There is little doubt that the benefits of transitioning the USF to a broadband infrastructure-based system far outweigh the costs. Nor is there any doubt that ensuring universal access to advanced communications technologies will improve the lives of all Americans. The goal of the USF Transition NPRM must be the replacement of the existing subsidy system with one that is efficient, rational, and consistent with the law. This will be no easy task; less ambitious plans offered during the last Commission created a political firestorm and failed to garner widespread support. Turning this vision of USF modernization into reality will require both analytical rigor and political courage.

INCREASING THE AVAILABILITY, CAPACITY AND COMPETITIVENESS OF MIDDLE MILE INFRASTRUCTURE MAY BE THE KEY TO LONG-TERM RURAL-URBAN BROADBAND EQUITY, BUT MORE DATA IS NEEDED TO DETERMINE THE SCOPE AND NATURE OF THIS PROBLEM

As discussed above, even if an ISP deploys robust last-mile infrastructure, it won't matter if the middle-mile backhaul capacity to the wider Internet is lacking -- an Internet connection is only as robust as it weakest link. Many small rural cable, wireless, and telco carriers cite the lack of adequate and affordable middle mile capacity as a major impediment to service deployment or advancement. In many areas, the former Bell companies dominate the market for wired middle-mile lines, a legacy from the monopoly telephone era. The FCC maintains some limited pricing discipline on a subset of these middle mile lines, but evidence suggests that prices and profits are far too high even among the middle mile "special access" lines that remain under price caps.

The National Broadband Plan recognizes the middle mile pricing issue, but offers little in the way of policy proposals to solve this problem. Instead, the Plan simply recommends that the Commission complete the pending special access proceeding, and suggests that more spectrum be allocated for wireless middle-mile service. While special access reform is long overdue, it is important to note that special access circuits compose just a small subset of the middle-mile market, and are circuits optimized for voice transmissions. The NBP mentions the FCC's past deregulation of the other non-special access high-capacity middle-mile

[27] The Plan predicts freeing up $4 billion by 2020 through the elimination of the Interstate Access Support program, which was originally designed to offset the impact to price cap carriers stemming from the Commission's mandated phasing down of the per minute interstate access rates paid to these carriers for terminating interstate long-distance calls.

broadband services, like Ethernet, but makes no assessment of the health of this market, fails to note what the extent of deployment of these services is, and does not discuss whether or not pricing in this market is competitive.

This lack of knowledge is a problem, particularly for long-term public policy planning. The NBP sets a goal of affordable 100 Mbps downstream /50 Mbps upstream service by 2020, but makes no mention at all how such services will come to rural America. Advances in cable modem capabilities brought by the DOCSIS 3.0 technology will make this goal a certain reality in many parts of the country, but only on those systems that have access to adequate middle-mile backhaul capacity. The FCC can modernize the USF to ensure that every American home is served either by a DOCSIS 3.0 cable or a fiber-to-the-home telco provider, but unless those lines are connected to robust fiber-level quality backhaul, we will merely find that our job is still not finished.

Thus, in addition to the need to collect useful data on the state of last mile broadband deployment, the Commission needs similar data on middle-mile infrastructure. In the fall of 2008 the Commission initiated a Further Notice of Proposed Rulemaking on the issue of middle mile data, tentatively concluding that this type of data (similar to some of the data that used to be collected in the ARMIS reporting system from price-cap carriers) should likely be collected from *all* broadband providers.[28] However, as was the case with last-mile data, the FCC has failed to move on this wise and overdue conclusion. We hope this issue will be taken up when the Commission finally moves forward on the data collection issues identified in the NBP.

A BRIEF WORD ON JURISDICTION:
TRUST IN THE LAW AND THE DELIBERATIVE WISDOM OF CONGRESS

In the wake of the *Comcast v. FCC* decision, the Commission's authority to act in the broadband arena has been called into question. But in the debate of what the FCC's next step should be, it seems that many have lost the thread of history, placing adjectives like "radical" onto the framework for innovation and competition that Congress established for our nation's two-way communications networks.

Our nation's laws are not made in a vacuum, nor are they made with haste. The lawmaking process is one that is designed to produce laws that are flexible and withstand the test of time. This is achieved in practice through the deliberative wisdom of the Congressional process, which often bases our laws around basic bedrock principles -- principles that transport the law through changing times. Our Communications Act is guided by the principles of universal service, non-discrimination, interconnection, competition and reasoned deregulation.

These principles, through the framework of the 1996 Act, were intended to foster the development of a robust, advanced and competitive two-way communications market. And in many ways they have. But in other ways they have not, due not to flaws in the law, but flaws in implementation of the law. This is why the current heated debate over broadband's place in Title I or Title II seem so odd when viewed in context with the Communications Act itself.

Of course two-way broadband transmission networks belong in Title II, because that's where Congress put them, and intended them to stay. But that does not mean that Congress intended for a permanent heavy hand of regulation to apply to these advanced networks. Again, Congress recognized that as competition develops, reasoned deregulation is an appropriate response.

Section 10 of the Act was the path of reasoned deregulation chosen for our nation's two-way communications networks. FCC Chairman Michael Powell chose a different path to deregulation, a path that involved sometimes metaphysical-like definitional interpretations of legal classifications. Mr. Powell, and later Chairman Martin felt that they could follow this path to deregulation, while preserving the Commission's ability to uphold the principles of universal service, non-discrimination, interconnection and competition. But

[28] *Service Quality, Customer Satisfaction, Infrastructure and Operating Data Gathering*, WC Docket No. 08-190, Memorandum Opinion and Order and Notice of Proposed Rulemaking, 23 FCC Rcd 1364, 1382 para. 34, 35 (2008).

the legal theory they based this assumption on has now, through the DC Circuit's decision, been proven to be unworkable. Powell and Martin made errors that are now proving to inhibit the Commission's activities in areas such as universal service for advanced networks that Congress clearly placed under the FCC's authority. This outcome, and its unworkability was predicted by Justice Scalia in his dissent in the *Brand-X* case:

> "The main source of the Commission's regulatory authority over common carriers is Title II, but the Commission has rendered that inapplicable in this instance by concluding that the definition of "telecommunications service" is ambiguous and does not (in its current view) apply to cable modem service. It contemplates, however, altering that (unnecessary) outcome, not by changing the law (*i.e.*, its construction of the Title II definitions), but by reserving the right to change the facts... [by asserting] its undefined and sparingly used "ancillary" powers... Such Mobius-strip reasoning mocks the principle that the statute constrains the agency in any meaningful way."[29]

In other words, Powell and Martin's legal interpretations physically "broke" the law, making it unworkable except through their ancillary authority theory. In pursuing the principle of reasoned deregulation in a manner not laid out by Congress, as Justice Scalia put it, "the Commission has attempted to establish a whole new regime of *non*-regulation... The important fact, however, is that the Commission has chosen to achieve this through an implausible reading of the statute, and has thus exceeded the authority given it by Congress."

So the FCC is now placed at a crossroads, where it finds one legal framework called into question, and the framework established by Congress waiting to be re-embraced. The notion now promoted by some, that "reclassification" would be a return to "century-old rules made for railroads and Ma Bell phone monopolies" is simply incorrect. Reclassification would simply return the framework that Congress adopted for all two-way communications networks in 1996, a framework that today still applies to all of the high-capacity data lines in the very competitive enterprise broadband market. Reclassification, followed by Section 10-based forbearance will preserve the status quo deregulatory approach, but will put the Commission's plans for universal service and consumer protection back on proper legal ground. Reclassification simply puts the Commission's rules back in harmony with the law, and is justified by current realities of the marketplace that make the original 2002 decision inappropriate for today.

But make no mistake, the Commission's universal service reform plans are in legal limbo as a result of the consequences of the past FCC classification decisions. Free Press is a strong supporter of an efficient and modernized USF, and we have for years argued that the Commission could carry out this task through the use of Title I authority. But this was always a supposition rested upon the untested strength of the Powell/Martin Title I legal theory. In 2008, Verizon, told the Commission that its "authority to use federal high cost subsidies to promote universal service is limited to 'telecommunications services.' As the Commission has found, and the courts affirmed, broadband Internet access service is an information service, not a telecommunications service. Thus broadband does not qualify under section 254 as a supported service eligible for high cost subsidies."[30] In 2002, the Federal State Joint Board on Universal Service wrote that because of the information service designation, "broadband Internet access services could not be included within the definition of supported services, because section 254(c) limits the definition of supported services to telecommunications services."[31] Though there may have been room for rebutting these assertions in the past, the recent court decision has now essentially closed any avenue to reach a sound advanced USF policy through ancillary authority.

A quirk in interpretation of the law does leave one solid path to extend USF support to broadband, but it is one that brings the baggage of the old USF along with it. Because some small rural LECs chose to retain the classification status of their DSL transmission services as Title II telecommunications services (an option left to them by the FCC's *2005 Wireline Order*, so that these carriers could participate in NECA tariff pools), the Commission could technically extended broadband subsides to these carriers. But this excludes

[29] *National Cable & Telecommunications Ass'n v. Brand X Internet Services*, 125 S. Ct. 2688 (2005) (*NCTA v. Brand X*).

[30] *See* Comments of Verizon, *In the Matter of Federal-State Joint Board on Universal Service*, WC Docket No. 05-337, April 17, 2008.

[31] *See Federal-State Joint Board on Universal Service*, Recommended Decision, 18 FCC Rcd 2943 (2002).

other carriers offering perhaps superior and less expensive technologies, such as cable modem or fixed and mobile wireless. Given that much of the NBP's proposed framework relies on lowest-cost technologies chosen through competitive bidding, it would be unfortunate if only existing subsidy recipients were able to take advantage of the modernized USF. This potential outcome just serves to highlight how far the Commission's interpretation of the statute has strayed from the plain intent of the statute itself.

Though some may feel that the Communications Act is outdated, the fact is Congress overhauled the law in 1996 with an eye towards competition and technological convergence. Title II is not a framework for monopolies offering telephone service, but a framework for competition in two-way communications networks, including advanced broadband networks. Furthermore, the notion that the universal service, non-discrimination, interconnection, competition and reasoned deregulation principles that are at the heart of basic title-II common carriage is somehow outdated ignores the plain fact that many of our law's basic principles are hundreds of years old. From the ideas embodied in the Constitution to the ideas embodied in common law, basic principles often withstand the test of time. In enacting the 1996 Act, Congress certainly understood that non-discrimination and interconnection are the keys to having a robust two-way communications infrastructure, regardless of changes in technologies.

We trust in the law, and are certain that the deliberative wisdom of Congress, if once again properly implemented, will bring the right outcomes that we all agree are desirable.

CONCLUSION

As consumer advocates with a strong desire to see the goals of Universal Service as articulated in the Communications Act reached in a manner that is fair and efficient to all ratepayers, we welcome the National Broadband Plan's constructive ideas on how to better allocate the scarce resources of the High Cost Fund. This plan reflects the reality that USF reform and the policy framework for achieving universal deployment and adoption of affordable broadband Internet access services are inextricably linked.

But we are concerned about some of the underlying data that informed this analysis, and will work with the Commission in the future to ensure that it collects good data that it must have to inform good policies. Though we have concerns about some of the proposed program design, we expect the Commission will proceed in an open, transparent and fair manner with an open mind to all alternative ideas. Going forward, we hope that the Commission keeps the long-term picture in mind, and ensures that as we close the existing current-generation technology digital divide, that we don't replace it with a next-generation technology digital divide.

Mr. BOUCHER. Thank you very much, Mr. Turner. Mr. Dankberg.

STATEMENT OF MARK DANKBERG

Mr. DANKBERG. Good morning, Chairman Boucher, Ranking Member Stearns, and the members of the committee. Thank you very much for the opportunity to present. I am Mark Dankberg. I am co-founder of ViaSat, Inc. It is a company I started in my house about 24 years ago. It has grown to have about 2,000 employees all around the country. And for the last 10 years, we have been very focused on bringing broadband to America by satellite. We are close to a billion dollar company and we provide this technology all around the world. We were investing about $1 billion starting 2 years ago to do this, and I wanted to cite a famous American, Will Rogers, who, believe it or not, is a broadband expert. When Will Rogers said it is not the things that you don't know that will hurt you. It is the things you think are so but—what you think is true but ain't so—so let us go back. I am going to tell you 3 things that you think are so—that you think are true and ain't so.

One is that lack of availability of broadband is primarily a rural problem. I am going to show you evidence from our subscribers where they are that it is actually—there are more people in Ohio, Virginia, New York, California without broadband then there are in Wyoming and Montana. There are higher percentages in the rural states but more people in the developed states. Number 2, that we think it is good business to serve people who don't have broadband available. That is what we are doing. We are investing in it. And, third, that satellite actually can provide a very good service. It is not a second rate service. So the first thing is this map. Here we show the State or Virginia. The green areas are areas that are mapped to have availability of one or more terrestrial broadband services.

Yet, WildBlue, which has over 400,000 subscribers, more than half of our subscribers in the State of Virginia are in areas that are supposed to have broadband available. It is strong empirical evidence that shows exactly what we have been talking about that the availability of broadband does not extend to all people. These people—90 percent of our subscribers tell us that they can't get terrestrial broadband, even those people that are in these areas that are green. Now this means that it is a much tougher problem. It is not a problem just in rural areas. It is a problem around cities. The next map shows Ohio, and you can see it is almost the same thing. The green areas, all the blue dots are subscribers who have gotten satellite because they can't get terrestrial broadband even in those areas.

So you can imagine that if we think we are going to try to serve all these unserved people, we would essentially be building out infrastructure throughout the State of Ohio, not just in the rural areas. So satellite is actually an excellent way to provide broadband to these scattered people, whether they are in rural areas or around metro areas. This next chart shows basically how people use the internet, and I wanted to make that point. See if we can move on to the next chart, please. It is a pie chart, and it shows data from Cisco Systems that shows what the applications are that people use on the internet, and you can see it is dominated by 3 things, video, web and e-mail, and peer to peer. For those services, which make up 95 percent of internet access, satellite is actually excellent service. We also can provide gaming services. We can provide voice and video services.

And to correct sort of misperceptions, I would like to show a quick 40-second clip. I wish we could demonstrate it here. But this is just 40 seconds slice of clip of an actual satellite internet session showing people doing voice-video communications and web browsing that I think will be really illuminating. If we could move it out, please. I think we might have to adjust the volume a little bit. Will you turn up the volume, please?

[Video shown.]

Mr. DANKBERG. The point being is it just looks like an internet session, and it is. It is just like any internet session that you would have on cable or fiber optics except that it is done over satellite. And the point that we are trying to make is that this is far, far more effective. The next slide just shows where people talk about thousands of dollars to build out or tens of thousands of dollars to build out services. Using satellite is basically $5 is the cost to make satellite available to any place in our coverage area. We provide service at $49 a month and if people elect service the service quality that you saw on that video clip, which we believe is very, very comparable to cable or terrestrial broadband would cost less than $1,000 to provision at the level that you saw in that video clip.

We also make that available on a wholesale basis for less than half that $49 price to retailers, including DISH TV, DirecTV, the National Rural Telecom Cooperative, Quest, and AT&T. We think the FCC properly noted that this can be a good service. What they said is satellite with these next generation satellites such as the ones that we are offering can make service available to any American. All they question is whether this is a scalable solution. I want to point out it would take about 7 satellites, that is 7 next generation satellites to make that service available to 7 million subscribers anywhere in the United States. There are already 5 first generation satellites that are up. They are not as good as the one that we are launching now but they indicate the level of investment private industry has already made. Go to the next slide, please. There are 2 of these next generation satellites currently under construction. The others will be available 1 year from now and will make the level of service that you saw available to approximately 1 to 1½ million people in our coverage area. And just by comparison there is 25 existing satellites just for satellite TV over the United States today.

So the main 3 points I would like to make at the end is we do believe private industry can deal with this. If the government feels though that the subsidy should be used what we would say is that it should be technology neutral to let this very cost-effective technology be one of the alternatives. We recommend that it be competitive, that the way you compete is to provide equal service at the lowest cost and that the other important point is that the consumer should have a choice, that they shouldn't be forced to get service from a particular subscriber because one company has been chosen as the designated entity in that area. And if you look at it——

Mr. BOUCHER. Mr. Dankberg, you are well over your amount of time here. Can you just wrap up quickly, please?

Mr. DANKBERG. I was just going to say the 30 million satellite homes that get TV in the U.S., nobody would think people would use satellite for TV.

Mr. BOUCHER. Thank you very much, Mr. Dankberg.

[The prepared statement of Mr. Dankberg follows:]

Testimony before the Committee on Energy and Commerce
Subcommittee on Communications, Technology and the Internet
United States House of Representatives

Hearing on the National Broadband Plan:
Deploying Quality Broadband Services to the Last Mile

Mark Dankberg
Chairman and CEO
ViaSat, Inc.
April 21, 2010

Chairman Boucher, Ranking Member Stearns and other Members of the Subcommittee, I am Mark Dankberg, Chairman and CEO of ViaSat, Inc. ("ViaSat"). I am pleased to have the opportunity to testify before you today on ViaSat's views about the broadband availability gap and the most cost-effective means of closing that gap.

ViaSat is a U.S.-based company that I co-founded in my home 24 years ago. ViaSat is a leading provider of communications networks to U.S. consumers, enterprises, and the U.S. Department of Defense. We are also one of the leading providers of consumer broadband, enterprise and government satellite networks on a global basis. We invent, design and build telecommunications technology. Our goal is to transform the way satellite broadband services are provided today to homes, businesses, community organizations, and first responders, as well as for other national security purposes. We also plan to help ensure that all Americans have the opportunity to access quality broadband services.

We are investing over $400 million in the deployment of a highly innovative new satellite network that will more than triple the quality of satellite broadband service in the United States (and Canada), resulting in quality levels and price points that are comparable to, or better than, today's cable modem, DSL or wireless broadband services. Just four months ago, we invested almost $600 million more to acquire WildBlue Communications, Inc., which is one of the top 20 broadband ISP's in the country and serves over 420,000 U.S. homes today by satellite. WildBlue, and its distribution partners, including DirecTV, DISH Network, the National Rural Telecommunications Cooperative, and AT&T will be the means by which we will deliver this satellite broadband technology to the American public.

ViaSat supports the efforts of Congress and the Administration to facilitate the deployment of affordable broadband services to all Americans. We are encouraged that the

FCC's National Broadband Plan explicitly recognizes the major improvements we are making in satellite broadband, as well as the role satellite can play in cost effectively ensuring universal availability of affordable broadband access.

But there is another important role that satellite can serve here today, and that is to help more accurately assess the extent, and the geographic distribution, of the broadband availability gap in the U.S. today. We'll show quite convincing evidence that the broadband availability gap is in fact bigger than conventional mapping techniques suggest. We'll also show that unserved homes are scattered almost randomly around population centers in a way that will make reaching them by conventional terrestrial networks much more expensive than might otherwise be expected. We'll give you a quick glimpse of the dramatic improvements offered by the latest generation of satellite broadband technology. And, we'll suggest how that technology can help close the availability gap in an extremely cost effective way by either eliminating or greatly reducing the amount of government funding needed to meet the universal availability goal established in the National Broadband Plan.

I. Millions of Unserved and Underserved Homes Are Not Yet Accounted For

The National Broadband Plan aims to ensure that, by 2020, all citizens have access to affordable broadband services with a minimum actual download speed of 4 Mbps. One of the key findings in the National Broadband Plan is that "14 million people in the United States living in 7 million housing units do not have access to terrestrial broadband infrastructure capable of this speed."[1] This estimate relies on data aggregated from several sources, including self-reporting of service areas by broadband service providers.

The National Broadband Plan acknowledges that data must be collected on an individual household level and recommends that service provider data be supplemented with self-reporting by consumers:

> To improve its ability to make informed policy decisions and to track deployment, adoption and competition issues, the FCC should transition as quickly as practical to collecting location-specific subscribership data by provider, technology, actual speed and offered speed. Such data would make it possible for the FCC to aggregate the data to any geographic level rather than relying on providers to allocate subscribers by census tract or block. The FCC should also continue to utilize consumer-driven data collection methods, such as voluntary speed tests and broadband unavailability registries.[2]

We agree with this point. In our experience, existing data on broadband availability — including the offered speed — has been estimated too coarsely, and significantly understates the availability gap. That is, current assessments tend to assume that if a particular geographic area has service available *anywhere* within its boundaries (*e.g.*, within a census tract), then the *entire* geographic area must have that service. In many cases, that assumption is almost certainly overly optimistic.

We know from experience that *today's* broadband users do not choose a satellite service if they have a terrestrial broadband alternative; satellite today is widely viewed as a service of last resort. We intend to fundamentally change that perception of satellite broadband with the launch of ViaSat-1 next year, by making it a compelling value proposition. But today's

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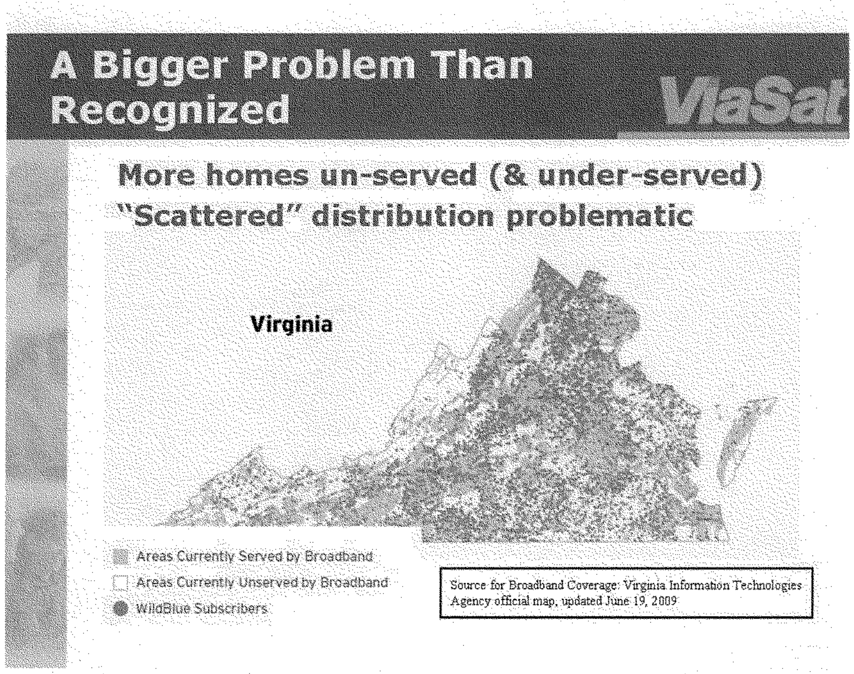
1 *See* Federal Communications Commission, *Connecting America: The National Broadband Plan* (2010), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296935A1.pdf ("National Broadband Plan"), at 20.

2 *Id.* at 43.

satellite broadband service is not very competitive with DSL or cable modem service because the speeds are comparatively low given the monthly subscription fees.

For this reason, a map showing the location of today's satellite broadband subscribers is a quite effective way to identify geographic areas at a very fine level of detail (*i.e.*, individual homes) that are not otherwise served. The illustration in the slide below superimposes actual WildBlue subscriber locations in Virginia on top of the state's assessment of regions currently served by terrestrial broadband.



As you can see, about half of WildBlue satellite broadband subscribers in Virginia are located in areas identified by state mapping projects as "served." Yet almost 90 percent of WildBlue's subscribers have indicated to us that they have no choice of broadband service other than satellite. As the FCC seems to suspect, it appears the existing methods of data collection materially over-estimate broadband availability. This is why we recommended a year ago to NTIA, RUS and the FCC that they consider adopting a mechanism that would allow citizens to "raise their hands" and be counted as unserved or underserved.[3]

Even if that type of a mechanism is not adopted, examining WildBlue's subscriber base would represent an effective method of "utilizing consumer-driven data collection methods," as the FCC proposes. Our subscribers today have effectively self-identified themselves as unserved by selecting satellite broadband service. Using satellite subscription data to augment current data collection efforts would provide valuable information about broadband availability in the U.S.

Many people have an intuitive sense that satellite broadband serves predominantly rural and remote areas. Our subscriber maps tell a different story. Unserved homes are scattered more randomly and broadly among relatively highly populated geographic regions than most would anticipate. The map of Virginia is typical of this phenomenon. The following slide illustrates the same type of distribution in Ohio.

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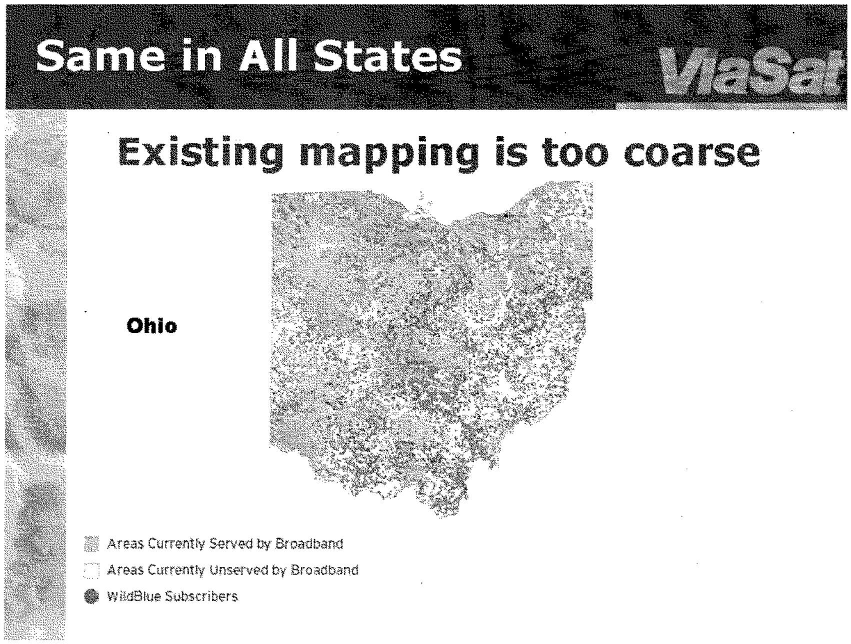
3 *See The Commission's Consultative Role in the Broadband Provisions of the Recovery Act*, FCC GN Docket No. 09-40, Comments of ViaSat, Inc., at 9-11 (Apr. 13, 2009); *American Recovery and Reinvestment Act of 2009 Broadband Initiatives: Joint Request for Information*, NTIA/RUS Docket No. 090309298-9299-01, Comments of ViaSat, Inc., at 9-10 (Apr. 13, 2009).



It bears emphasis that when unserved households are scattered randomly throughout areas that are otherwise well-served, it changes the calculus for subsidizing the connections of those homes. The terrestrial deployment model of identifying unserved towns and communities and then embarking upon a construction project does not address the issue. Indeed, a sizable percentage of unserved households are within the areas identified as served. It would make little sense to subsidize a dominant or monopoly terrestrial provider to connect the random homes in its coverage area that it has effectively *chosen* not to serve.

Our experience suggests that, in the aggregate, these random "left-out" homes comprise millions of households across the U.S. As discussed in more detail below, the best mechanism for serving those households would be through fair and open competition among multiple broadband service providers. And if government subsidies are made available, each consumer should be empowered to make the ultimate determination as to how to use that government subsidy toward the service that is best for his or her individual situation. That same methodology also can be effective for reaching any and all homes that want an affordable broadband service that meets the FCC's universal service objective.

II. Satellite Broadband Technology Is Capable of Providing a Quality Experience

We understand that satellite broadband today is considered by some as a service of last resort. Nonetheless, today almost 1 million Americans are satellite broadband subscribers, and the industry is thriving as it serves the most difficult to reach households without *any government assistance whatsoever*. As a new entrant, ViaSat realizes there is great potential for satellite broadband to be a self-sustaining, profitable, competitive enterprise — *if we can make the service much better, and make it a better value for subscribers.* ViaSat is doing just that. By making substantial investments to implement a revolutionary satellite design, ViaSat intends to place the quality and price of satellite-delivered broadband on par with median-quality terrestrial broadband services.

The current evolutionary stage of satellite broadband services is very similar to that of the satellite television industry in 1994 – before the launch of the two largest Direct Broadcast Satellite ("DBS") providers, DirecTV and DISH Network. There were a few million backyard satellite dishes measuring 7 to 10 feet in diameter[4] — with consumers taking extreme measures to receive satellite video services from literally dozens of different satellites, often on a

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4 *See In the Matter of Competition, Rate Deregulation, and the Commission's Policies Relating to the Provision of Cable Television Service*, Report, 5 FCC Rcd 4962, at ¶ 103 (1990) (discussing "Home Satellite Dish" service).

catch-as-catch-can basis. At that time, some visionary entrepreneurs realized that satellite television could be a great business if they could improve the product, make it as good as or better than terrestrial video services, and make it easier, more convenient, more reliable and more predictable than then-existing satellite video services. The key to success in that industry segment was launching a new class of dedicated satellites (optimized for DBS), and continuing to improve satellite and ground system technology to allow the addition of an increasing number of channels, movies on demand, local programming, High Definition, and other innovative services. Today, approximately 30 million Americans receive video services via satellite,[5] many of them *prefer* satellite-delivered video over competitive offerings from cable and telephone companies, and virtually all Americans get a much higher quality video experience from their cable or telephone company because of the competitive forces that satellite video providers brought to the industry.

In January 2008, ViaSat commenced construction of its ViaSat-1 satellite, which promises to revolutionize the satellite broadband industry, and to have the same competitive effect on DSL, wireless broadband and cable modem service that DBS has had on cable, IP and fiber-delivered television. ViaSat-1 is expected to deliver almost 20 times the bandwidth of WildBlue's best on-orbit satellite and over 100 times the bandwidth efficiency of the best conventional satellites designed and launched as recently as six years ago.

Bandwidth is *the* central value proposition of a broadband service. That is made clear by the explosive growth in consumer demand for high-bandwidth, real-time Internet

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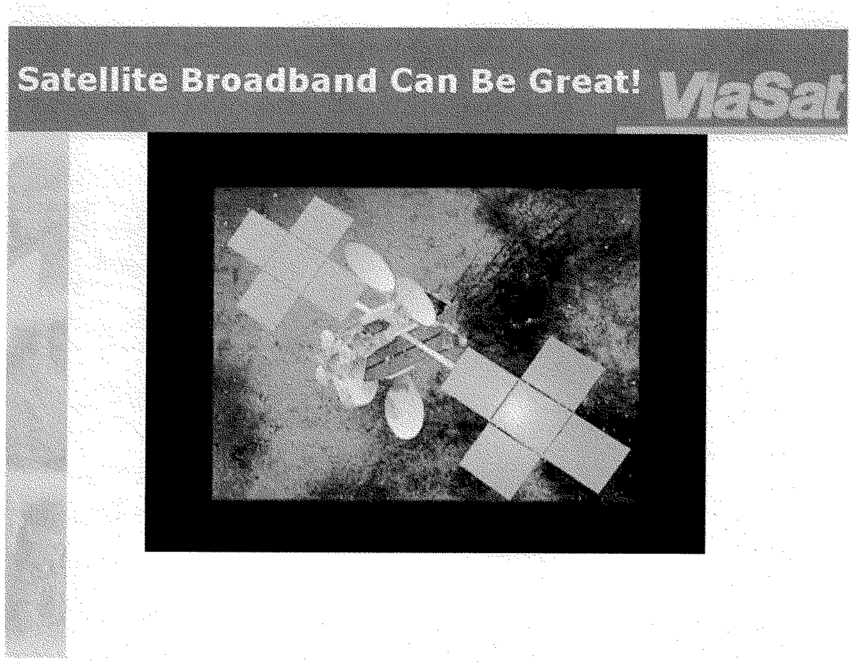
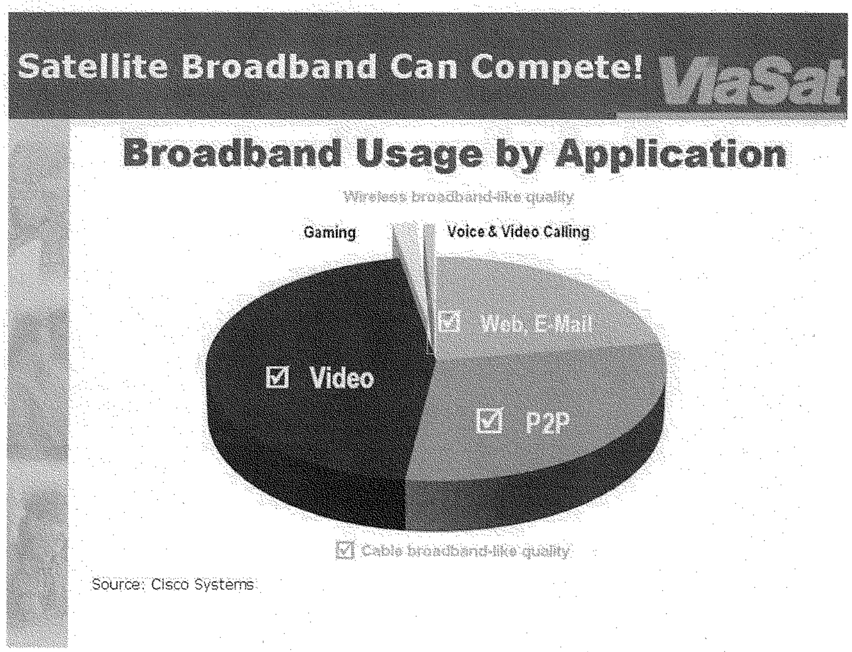
[5] *See* DIRECTV SEC Form 10-K for FY2009, at 4 (filed Feb. 26, 2010) ("DIRECTV 2009 10-K") (noting that DIRECTV provided video service to over 18.5 million subscribers as of the end of 2009); DISH Network Corporation SEC Form 10-K for FY2009, at 1 (filed Mar. 1, 2010) ("DISH 2009 10-K") (noting that DISH Network Corporation served approximately 14.1 million customers as of the end of 2009)..

applications. We are pleased by the FCC's efforts to date in making adequate spectrum available for satellites to support these growing bandwidth needs, and we look forward to working with the FCC to enable additional flexible uses of the radio spectrum, to further increase the bandwidth available on broadband satellites.

While we cannot demonstrate our service in the hearing room, we will show a video clip to illustrate the speed and responsiveness made possible by ViaSat's breakthrough, high-bandwidth, satellite technology.



The slide below depicts data provided by Cisco Systems highlighting how the bandwidth improvements of ViaSat-1 directly target the broadband applications that subscribers use the most.



By far, the greatest amount of Internet bandwidth is consumed by video (viewed on a PC or television set) and by peer-to-peer services. The success of DBS services demonstrates that satellite technology is extremely well-suited for providing competitive video services. Likewise, recent advances in wide area network (WAN) acceleration technology (a variant of a rapidly growing technology used for remote access and "cloud computing" for enterprise customers) enable quality-of-service improvements, and make it possible for ViaSat's satellite network to provide cable modem-like speeds and responsiveness for Web surfing, e-mail and other interactive data services.

ViaSat-1, and other broadband satellites in the same generation, will serve as a competitive alternative to wireless, DSL, and even cable for millions of subscribers. Satellite broadband over ViaSat-1 and satellites using comparable technology will be very competitive with cable modem service for those applications that consume about 95 percent of the data carried on the Internet today. The other applications tracked by Cisco[6] — VoIP, video conferencing, and "first person shooter-style" gaming — are more sensitive to time delays that can degrade the quality of the service. In general, our ViaSat-1 satellite system will provide a satisfactory experience, quite comparable to a terrestrial mobile broadband wireless service, for those types of applications. In some cases, we will provide an experience that in fact will be superior to DSL (*e.g.*, where connection speed is even more important than latency, such as with video teleconferencing).

The National Broadband Plan proposes the creation of standardized methods for measuring and disclosing actual broadband service quality, centered on actual speeds.[7] We strongly endorse that approach and believe that such transparency will make satellite-delivered broadband a more attractive competitive alternative for many consumers. We also believe that the ubiquitous availability of a quality and affordable satellite broadband service will impose positive competitive pressures on all terrestrial services, in the same way that satellite video imposes competitive pressure on terrestrial video service providers to deliver greater value to the American customer.

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6 *See Cisco VNI Forecast Widget: Projecting global IP traffic growth, at* http://www.ciscovni.com/vni_forecast/AdvancedEditor.htm (last visited Apr. 18, 2010).

7 *See* National Broadband Plan at 46 (Recommendation 4.5).

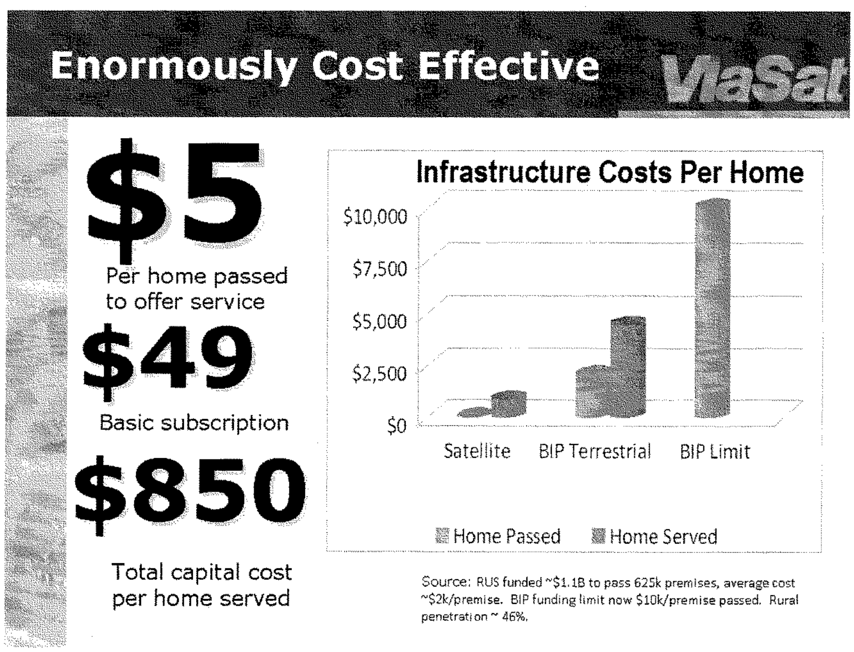
III. Satellite-Delivered Broadband Is an Extremely Cost-Effective Solution

The fundamental competitive advantage that satellites have over terrestrial delivery mechanisms is the enormous capital efficiency inherent in satellite infrastructure. All terrestrial technologies have capital infrastructure costs that are proportional to the distance between the homes they serve and the core network infrastructure, such as a central office. Satellite technology, on the other hand, is largely cost-insensitive to distance. Satellite technology avoids the need to build and maintain expensive last-mile and middle-mile terrestrial infrastructure, the cost of which can be highly variable and increase exponentially with the distance of the consumer from the rest of the network. Rather, a satellite provider's capital infrastructure costs are largely fixed once the satellite is brought into service, and remote or hard-to-reach households are as economical to serve as any other household. This efficiency contributes to the enormous success of satellite-delivered video services in the U.S. today, and even more so in other parts of the world. Satellite video delivery gains economic leverage because the video bits transmitted by the satellite can be received (and shared) by a very large number of subscribers within the coverage area of the satellite without increasing the provider's cost to deliver the service.

A significant difference between satellite video service and satellite broadband service is that satellite video services largely consist of broadcasting the same programming to a large number of subscribers. Due to the shared nature of broadcast data, satellite video providers never really had to develop technology to lower the cost of delivering individual data bits. By contrast, satellite broadband services must deliver different data streams to each individual subscriber. The reason today's satellites were not optimized to deliver individual data streams is simple: *Until now, a big enough market did not exist to warrant the investment needed to develop such technology.*

That situation has changed. Today, there are about 1 million satellite broadband subscribers, capacity available on existing spacecraft is filling up, and we are launching new satellites to support the growing demand. That demand is also why ViaSat is investing over $400 million to re-engineer the design for broadband satellites, and thus enable the delivery of digital bits to individual subscribers in a cost-effective manner. And that is how we are changing the way satellite broadband will be delivered in the future.

The following slide illustrates the enormous economic benefits that result from driving down the cost of satellite bandwidth for individual broadband subscribers:



Cost per home passed is a critical metric in determining the capital efficiency of a broadband system. This is the case because broadband adoption has a direct economic impact on the cost of providing service. As the FCC correctly recognizes, broadband adoption is an even bigger national issue than *availability*.[8] This is especially true in rural America where adoption rates may be below 50 percent even when broadband is available.[9] The important question of how we educate citizens about the critical role that broadband can provide in creating employment, educational, health-related and other benefits is beyond the scope of today's testimony. For now, the critical point is that a current, real world, 50 percent adoption rate effectively *doubles* the capital cost of serving those who do subscribe. This is a consideration that should go into any decision to invest taxpayer dollars in broadband infrastructure.

In the case of satellite-delivered broadband service, the capital cost per home passed is extremely low, because the infrastructure is shared across an extremely large service area. In the case of ViaSat-1, we estimate the capital cost at about $5 per household.[10] No terrestrial technology comes even close to this.

Satellite service is extremely capital efficient and allows us to keep subscription rates reasonable, without government subsidies, even in areas with low population density or low subscriber density. This makes satellite broadband the perfect technology to provide "fill in" service to those millions of randomly scattered citizens who live in populated areas but who have been passed over by incumbent terrestrial service providers.

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8 *See* National Broadband Plan at 123 ("Lack of adoption is a larger barrier to universal broadband than lack of availability").

9 *See id.* at 167 (Exh. 9-A).

10 The coverage of the ViaSat-1 system will include approximately 80 million U.S. households, and will cost approximately $420 million for the satellite, launch, insurance, and the gateway facilities.

Satellite also is more capital efficient than terrestrial technology when comparing the cost per household actually served. In the case of ViaSat-1, the capital cost of the system, including the cost of satellite infrastructure, ground equipment and the customer premises equipment, is approximately $850 per household served, regardless of the location of that household.

In stark contrast to these $5/household-passed and $850/household-served figures for satellite, published data from the first round of the RUS BIP program suggest that government funding for last mile terrestrial broadband infrastructure alone will yield a capital cost of about $2,000 per household passed and $4,500 per household served.[11] This cost differential becomes even more severe as efforts are made to reach homes that are even more expensive to serve than the "lower hanging fruit" selected by applicants for the first round of BIP funding. Furthermore, for the second round of BIP funding, RUS said it would consider funding

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11 As of March 30, 2010, RUS had awarded approximately $1.067 billion for broadband projects. *See* USDA, *Agriculture Secretary Vilsack Announces a Recovery Act Broadband Initiative to Bring Economic Opportunity to the Fort Berthold Indian Reservation and Parts of Two States*, Press Release (Mar. 30, 2010). Twenty percent of this amount — or $213.4 million — would be a conservative estimate of the additional, private matching funds to be provided, based on recent experience in the RUS BIP program. *See* USDA, *Agriculture Secretary Vilsack Announces Rural Broadband Projects to Bring Economics Opportunity to Community in Eight States*, Press Release (Mar. 23, 2010) (noting that private funding equal to 45.5 percent of the RUS funding also would be contributed privately). Total investment in the RUS projects as of March 30, 2010 thus can be estimated to be at least $1.28 billion. This investment is intended to make broadband available to 529,000 rural households and 96,000 rural business and public facilities. *Id.* Therefore, the average cost per building passed associated with this RUS funding is at least $2,050. The broadband penetration rate in rural areas with broadband availability is approximately 46 percent. *See* Pew Internet and American Life Project, *Home Broadband Adoption 2009*, at 17 (June 2009), *available at* http://www.pewinternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf. Consequently, this RUS funding can be expected to serve approximately 287,500 buildings. As such, the average infrastructure cost per building served associated with this RUS funding is at least $4,454.

last mile projects at capital costs as high as *$10,000 per home passed.*[12] Notably, for an apples-to-apples comparison to satellite, these figures would also need to include the costs of the terrestrial middle mile.

And it also bears emphasis that the ViaSat-1 system will support service at monthly rates that are as low as $49 for a true broadband experience.

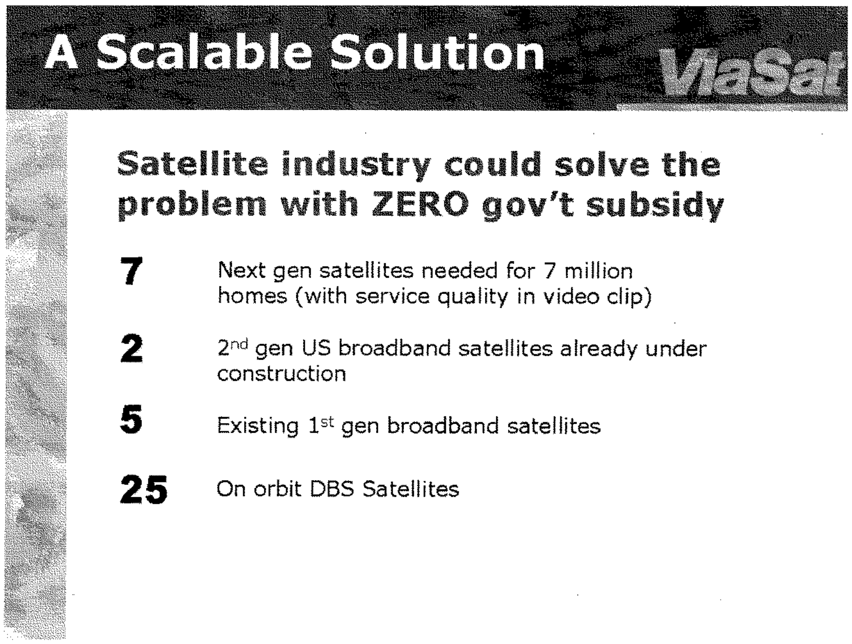
IV. Broadband Satellite Technology Is Scalable to Meet Future Capacity Demands

The National Broadband Plan acknowledges that satellites are capable of serving *any* household at the target universal service level of 4 Mbps,[13] but inquires whether satellites have the capacity to meet the needs of *all* unserved households.[14] This is not a shortcoming of satellite technology, but rather simply is an issue of scale that will be quite directly solved with the launch of additional broadband spacecraft. As detailed below, commercial satellite operators have a demonstrated track record of expanding satellite capacity by deploying more satellites to respond to consumer demand. As we will detail, history suggests that market forces will cause commercial enterprises to meet most of the need *without any government subsidies or other market intervention.*

12 *See Department of Agriculture, Rural Utilities Service, Broadband Initiatives Program*, Notice of Funds Availability, 75 Fed. Reg. 3820, 3823 (Jan. 22, 2010).

13 *See* National Broadband Plan at 137 (acknowledging that "satellite is capable of delivering speeds that meet the National Broadband Availability Target . . . .").

14 The Plan suggests that "satellite capacity can meet only a small portion of broadband demand in unserved areas for the foreseeable future" and that "while satellite can serve *any given household,* satellite capacity does not appear sufficient to serve *every unserved* household." *See id.* (emphasis added).



Based on extrapolating trends in bandwidth consumption, and technologies under development, ViaSat estimates that 7 million homes could be served at or above the National Broadband Plan's 4 Mbps "actual speed" target with the launch of only seven "next-generation" broadband satellites. Two of those seven (ViaSat-1 and Hughes Network Systems' Jupiter satellite) are already under construction and are scheduled to be launched in 2011 and 2012, respectively.[15] Thus, the five remaining satellites would need to be procured over the next eight

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15 *See ViaSat-1 to Transform North American Satellite Broadband Market*, Press Release (Jan. 7, 2008), *available at* http://www.viasat.com/news/viasat1-transform-north-american-satellite-broadband-market; *Hughes to Launch 100 Gbps Throughput Satellite in 2012*, Press Release (Jun. 16, 2009), *available at* http://www.hughes.com/HNS%20 Library%20Press%20Release/06-16-09_Hughes_to_Launch_100_Gbps_High _Throughput_Satellite_in_2012.htm.

years to meet the National Broadband Plan's 2020 target, and those spacecraft are logical replacements for the five existing older-generation satellites that are currently used and/or available for Internet access service (WildBlue-1, Anik F2, Spaceway 3, AMC-15 and AMC-16).[16] Expecting that five additional spacecraft will be procured and launched over the next decade is entirely reasonable.

Over a 15 year period, the satellite TV industry has launched over two dozen DBS satellites to serve 30 million subscribers (a comparable ratio of about 1 million subscribers per spacecraft).[17] We don't have a crystal ball, but historical experience in the DBS context strongly suggests that a similar level of growth in the satellite broadband industry is both technologically and financially feasible.

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16 WildBlue currently provides satellite broadband services using capacity on WildBlue-1, Anik F2, and AMC-15. *See* http://www.wildblue.com/company/index.jsp (last visited Apr. 17, 2010). AMC-15 and AMC-16 have identical payloads. *See SES GLOBAL Companies Contract Three Satellite Launches with ILS* (Apr. 19, 2004), *available at* http:www.ses.com. Hughes Network Systems provides broadband services over Spaceway 3. *See* http://www.skyway3.com/news.php (last visited Apr. 17, 2010).

17 *See* DIRECTV 2009 10-K at 9 (noting that DIRECTV "currently has a fleet of twelve geosynchronous satellites . . . ."); DISH Network 2009 10-K at 2 ("We own or lease capacity on 11 satellites in geostationary orbit . . . ."); *see also*, *DISH Network Launches New Satellite to Expand Industry's Largest HD Offering*, Press Release (Mar. 21, 2010) (indicating that recent launch brings the size of the network constellation to 15), *available at* http://dish.client.shareholder.com/releasedetail.cfm?ReleaseID=453561.

V. Any National Broadband Plan Subsidies Should Facilitate Competition and Consumer Choice

One of the proposals made in the National Broadband Plan requires very careful examination:

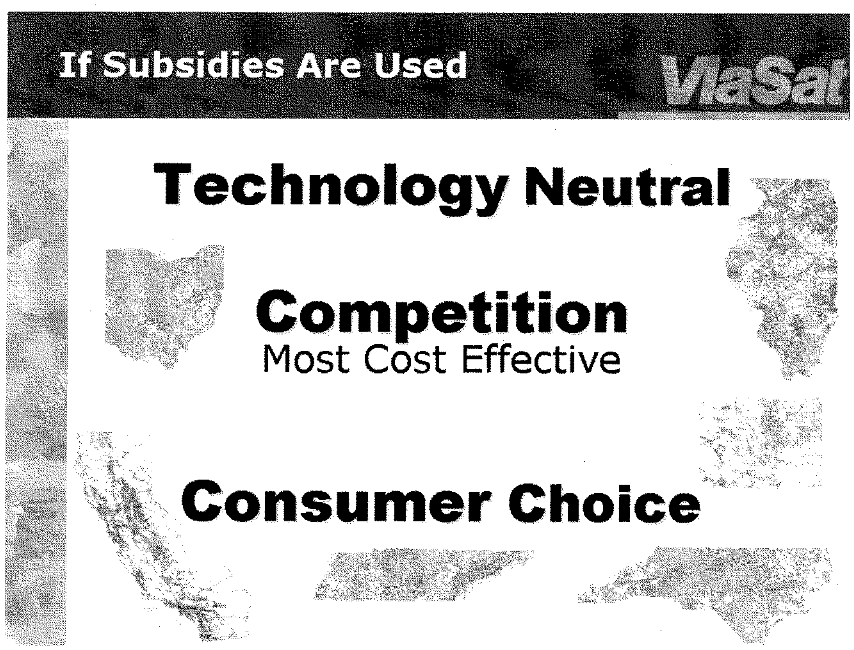
> There should be at most one subsidized provider of broadband per geographic area. Areas with extremely low population density are typically unprofitable for even a single operator to serve and often face a significant broadband availability gap. Subsidizing duplicate, competing networks in such areas where there is no sustainable business case would impose significant burdens on the USF and, ultimately, on the consumers who contribute to the USF.[18]

This proposal does not take into account, as we have illustrated quite vividly here, that a large proportion of unserved homes are scattered throughout geographic regions where two or more existing terrestrial service providers — such as a telephone company and a cable company — in fact exist. As a policy matter, if subsidies are used at all in that geographic region, the subsidy should go to whichever of the two service providers can more cost effectively serve the unserved premises. In fact, it would be most effective if each subscriber had the opportunity to choose which of the two available service providers would be better for that individual home, based on evaluating competitive offers from the two services (regardless whether the service is subsidized or not).

The FCC has properly recognized that satellite is perfectly capable of serving any of the unserved homes in the U.S., whether in a rural area or not, and at the target universal service quality level. Thus, all of the unserved homes in the U.S. that are reachable by satellite are in a position to choose from at least two service providers. In addition to satellite, those service providers also could be wireless, telco, and cable — and possibly more than one of each type. No doubt, there are disadvantaged Americans who need financial assistance. But we

[18] National Broadband Plan at 145.

firmly believe that the needs of those Americans would be served far better by developing a subsidy mechanism that allows them to choose, from among multiple alternatives, the service provider they believe will deliver the best mix of price and quality for their individual circumstances. For these reasons, we urge Congress not to adopt any subsidy mechanism that has the effect of favoring one particular broadband ISP in a particular region, over all other ISPs who also could serve that same region.



ViaSat agrees with the critical observation in the National Broadband Plan that "the exact role of satellite-based broadband and its impact on the total cost of universalizing access to broadband depends on the specific disbursement mechanism used to close the broadband availability gap."[19] We believe that the following five factors (discussed in detail above) present a compelling case that satellite should have a meaningful role in universalizing broadband access: (i) the extent of the availability gap, (ii) the sparse and relatively random dispersion of unserved subscribers (as shown by empirical consumer-driven data collection), (iii) the breakthrough gains in bandwidth efficiency being made by the satellite industry, (iv) the potential to create "gas mileage" like metrics to compare the actual delivered speeds of differing broadband technologies, and (v) the power of competition to drive value creation for consumers.

We also believe that those five factors present a compelling case for the government to adhere to two principles as it determines how to facilitate broadband deployment and adoption: competition and consumer choice.

If the government chooses to subsidize broadband availability at any level, ViaSat strongly urges that any adopted mechanism be open and transparent, and most critically, facilitate enduring competition. Moreover, given the wide dispersion of unserved households, ViaSat urges that any subsidies be provided through a mechanism that empowers every eligible American *to choose* how to spend his or her subsidy dollars. Using federal funds merely to further endow entrenched providers inhibits competitive entry into those markets and takes away the consumer's ability to choose a provider. Putting the choice of broadband service provider in the hands of the consumer cultivates a more competitive landscape. Such a mechanism would provide the incentive for service providers to compete to win customers, thus empowering end

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19 National Broadband Plan at 137.

users to choose the provider offering the best combination of price and quality. This approach also would foster the competition that is needed to drive future innovation in data transmission technologies.

* * * * *

Thank you for the opportunity to appear before you today to discuss these important issues. I would be pleased to answer any questions you might have.

Mr. BOUCHER. Mr. Carroll.

STATEMENT OF AUSTIN CARROLL

Mr. CARROLL. Good morning, Chairman Boucher, Ranking Member Stearns, and members of the committee. Thank you for allowing me to be here. My name is Austin Carroll. I am general manager of Hopkinsville Electric System in Hopkinsville, Kentucky, and I am testifying today on behalf of the American Public Power Association where I serve on the board of directors and the Kentucky Municipal Utilities Association, as well as my position at Hopkinsville Electric System. APPA is a national service organization that represents the interests of more than 2,000 publicly-owned, not-for-profit electric utilities located in all states except Hawaii. Exhibit 1 in your materials is a map showing the location of the APPA members nationwide. Many of these utilities developed in communities that were literally left in the dark during the era when the United States was electrified as private sector electric companies pursued opportunities in larger population areas.

State and local governments, therefore, undertook the effort to ensure that residents of their communities were served by their own power systems in recognition of the fact that electricity is critical to the economic development and educational opportunities and quality of life for its residents. Currently, over 70 percent of APPA's members are communities with less than 10,000 population, and approximately 45 million Americans receive their electricity from public power systems. Many of the public power systems were established primarily as the large utilities were unwilling to serve smaller communities and rural areas, which were then viewed as unprofitable. In these cases, communities formed public power systems to do for themselves what the private sector was either unable or unwilling to do at a fair price.

The same trend is occurring today in the area of broadband and advanced communications. Many public power systems are meeting the new Age demands of their communities by providing broadband services where such services are unavailable, inadequate or too expensive. These services, provided with high quality and affordable prices, are crucial to the economic success and quality of life of communities across the nation. Nationwide, 700 public power utilities provide broadband services to school districts, local governments, hospitals, and almost 200 provide internet services to the residents. Municipal utilities are nonprofit and do not provide dividends for stockholders. In Kentucky they pay wages that are comparable to that paid by the State of Kentucky. Many public power systems have secured loans or utilized municipal bonds to invest in infrastructure for broadband. Municipal utilities are locally owned and operated utilities that are governed by elected municipal councils or independent utility boards appointed by elected mayors. Thus, unlike large private sector broadband providers, municipalities' sole focus is the needs of their own small territories, and they are responsive to their residents through the electoral process.

It is not my purpose to criticize private sector telephone and cable companies' broadband investment, deployment and pricing decisions, but rather to illustrate the differences between these companies and municipal/public power utilities that deploy broadband services. This testimony focuses on broadband services provided by Kentucky municipalities, which I think will provide a particular useful example of the important role public power utilities have to play in making broadband available nationwide. And I have included a map of Kentucky so you can see the municipalities in Kentucky and the ones providing broadband services.

In May of 1998, our community board of directors agreed to run fiber optic cable to our substations around town in order to monitor the substations for electric outage prevention. Then in '99, we had ringed our city on the basis of ringing these substations with fiber optic infrastructure. At that time, broadband was not available in Hopkinsville. Recognizing the need for our community to participate in the global economy and have available all educational opportunities, HES elected to use our fiber infrastructure to provide broadband services to local businesses, industries, government entities and others needing high-speed communications.

We formed a subsidiary, EnergyNet, to manage that and we keep separate books on the EnergyNet side as opposed to the electric side. Bandwidth at reasonable prices quickly became a popular entity in our community. Kentucky Derby Hosiery, an international sock company, was our first customer. And after that, city building, emergency operations center, fire stations, police stations were connected. All schools were connected as well, and by becoming a USAC-approved provider of E–Rate services, we were able to reimburse the school system 80 percent of its cost of connectivity so major businesses in town are now connected over our system.

We have now also employed a mass network of radio transmissions across our city and that is our solution for the residential sector of Hopkinsville. We have continued to grow. We have built a network operations center that is a very hardened facility unlike anything else in our community, and we have several of our industries, hospital, and so forth, that locate their service there for security. Hopkinsville was initially handicapped because we didn't have a point of presence for a long distance company, and so it was very expensive to try to get broadband at wholesale prices into our community. We have now constructed a line to Bowling Green, Kentucky, where there was a point of presence, and we dropped our megabit cost from $125 to $20, which that savings had been passed along to our consumers.

But we now have a world-class system in Hopkinsville. We can provide broadband at prices that are competitive with major cities. I call them NFL cities. And we are hoping to be able to attract a large data center to our community because we have got all the resources to do so. So it is not only a service to our existing businesses and industry but as an economic tool as well. And I appreciate your allowing me to make these comments, and I look forward to your questions.

[The prepared statement of Mr. Carroll follows:]

American Public Power Association
1875 Connecticut Avenue, NW
Suite 1200
Washington, DC 20009-5715
202-467-2900
fax 202-467-2910
www.APPAnet.org

Written Statement of Mr. Austin Carroll, General Manager of Hopkinsville Electric System in Hopkinsville, Kentucky, on behalf of the American Public Power Association To the House Energy and Commerce Committee, Subcommittee on Communications, Technology and the Internet

The National Broadband Plan: Deploying Quality Services in the Last Mile

Wednesday, April 21, 2010

Written Statement of Mr. Austin Carroll, General Manager of Hopkinsville Electric System in Hopkinsville, Kentucky, on behalf of the American Public Power Association To the House Energy and Commerce Committee, Subcommittee on Communications, Technology and the Internet

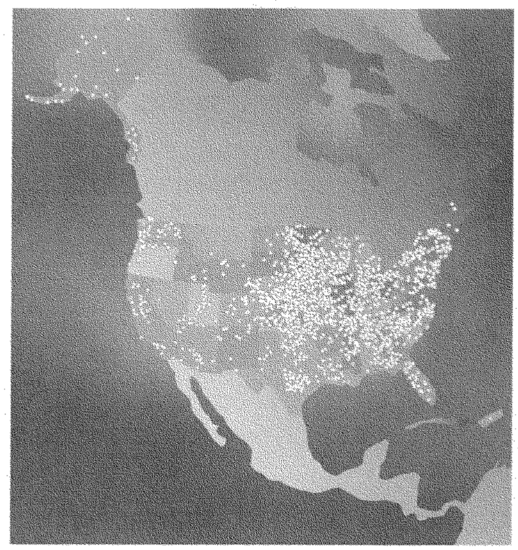
The National Broadband Plan: Deploying Quality Services in the Last Mile

Wednesday, April 21, 2010

Good morning Chairman Boucher, Ranking Member Stearns and Members of the Subcommittee. My name is Austin Carroll, and I am the General Manager of Hopkinsville Electric System in Hopkinsville, Kentucky. I am testifying today on behalf of the American Public Power Association (APPA), where I serve on the Board of Directors, and the Kentucky Municipal Utilities Association (KMUA), as well as in my position with the Hopkinsville Electric System.

APPA is the national service organization that represents the interests of more than 2,000 publicly-owned, not-for-profit electric utilities located in all states except Hawaii. Exhibit 1, below, is a map showing the locations of APPA members nationwide.

EXHIBIT 1



Many of these utilities developed in communities that were literally "left in the dark" during the era when the United States was electrified, as private-sector electric companies pursued opportunities in larger population centers. State and local governments, therefore, undertook the effort to ensure that residents of their communities were served by their own power systems, in recognition of the fact that electrification was critical to their economic development and the educational opportunities and quality of life of their residents.

Currently, over 70 percent of APPA's members serve communities with less than 10,000 residents, and approximately 45 million Americans receive their electricity from public power systems operated by municipalities, counties, joint powers authorities, states, or public utility districts. Many of these public power systems were established primarily because private utilities were unwilling to serve smaller communities and rural areas, which were then viewed as unprofitable. In these cases, communities formed public power systems to do for themselves what the private sector was either unable or unwilling to do.

This same trend is occurring today in the area of broadband and other advanced communications services. Many public power systems are meeting the new Information Age demands of their communities by providing broadband services where such services are unavailable, inadequate, or too expensive. These services, provided with high quality and at affordable prices, are crucial to the economic success and quality of life of communities across the nation.

Nationwide, 700 public power utilities provide broadband services to school districts, local governments, and hospitals, and almost 200 provide Internet services to their residents. Municipal utilities are non-profit and do not provide dividends for stockholders. In Kentucky, they pay wages that are comparable to those provided to state government employees. Many public power utilities have secured loans or utilized municipal bonds to invest in the infrastructure needed for broadband. Municipal utilities are locally owned and operated utilities that are governed by elected municipal councils or independent utility boards appointed by elected mayors. Thus, unlike large private-sector broadband providers, municipals' sole focus is the needs of their own small territories, and they are responsive to their residents through the electoral process.

It is not my purpose to criticize private sector telephone and cable companies' broadband investment, deployment and pricing decisions, but rather to illustrate the differences between these companies and municipal/public power utilities that deploy broadband services. Private sector companies must answer to shareholders and to Wall Street. Their decisions must of necessity be based on what maximizes their overall nationwide return. Municipal utilities, in contrast, answer to their local residents. And that is why I believe that, for our nation's smaller communities and rural areas served by public power, municipal broadband should be such an important element of our nation's broadband plan.

This testimony will focus on broadband services provided by Kentucky municipal utilities, which I think will provide a particularly useful example of the important role public power utilities have to play in making broadband available to our nation's unserved and underserved areas.

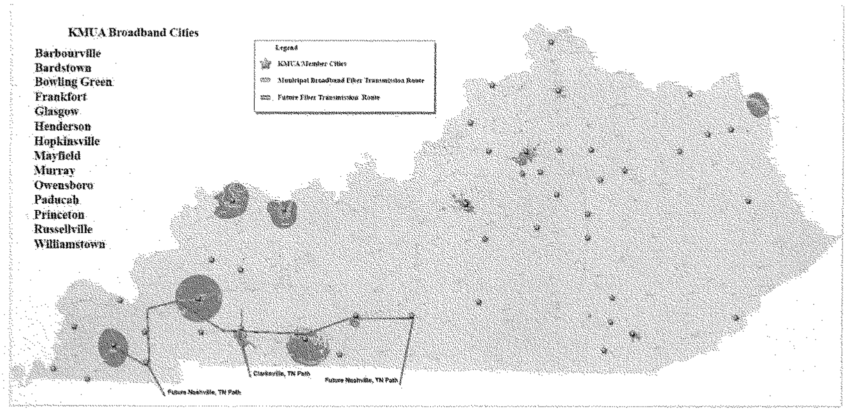
I would like to begin by letting you know about the positive economic development impact that Kentucky's municipal utilities have made in their communities by providing broadband to the residents and businesses in their areas. Businesses and jobs go to those communities where businesses can obtain low-cost, reliable and state-of-the-art broadband services. If a business cannot get those services in a particular community, it will go somewhere else.

In a largely rural state like ours, we have to be innovative to encourage Kentucky entrepreneurs and public entities to provide advanced communications services that will make us competitive with larger metropolitan areas. But we face even broader competition than that. Like our nation as a whole, Kentucky is competing with other countries – where broadband deployment and adoption far surpass what we have accomplished in the U.S. Internationally, European and Asian nations are outpacing the United States in developing the availability, usage and speed of Internet services.

Kentucky municipal utilities recognize that reality and, on behalf of the residents and businesses they serve, have responded. Kentucky is the nation's leader in municipal utility provision of broadband and other communications services. The small town of Glasgow, Kentucky, is recognized nationally as a pioneer in providing municipally owned advanced telecommunications and was the *first* to do so in the United States. Even large cities like Seattle, Washington, have contacted Glasgow for information on the municipal model for broadband communications services.

Thirteen municipal systems (six cable and seven wireless) provide broadband in Kentucky: Barbourville, Bardstown, Bowling Green, Frankfort, Glasgow, Henderson, Hopkinsville, Mayfield, Murray, Owensboro, Paducah, Princeton, and Williamstown. Exhibit 2, below, is a map showing where municipal utility broadband service areas are in Kentucky.

EXHIBIT 2



Although it is not reflected on this map, I want to point out that Williamstown has installed wireless equipment to serve all of Grant County. The County requested that the Williamstown Municipal Utility provide this service to the rural areas of Grant County because of a lack of response from the large private telecommunications companies.

The 13 Kentucky municipal utilities that shown on the map provide broadband services to almost 57,000 customers across the Commonwealth. And the numbers are growing every day.

Municipal Utilities Respond to their Communities' Broadband Needs.

Outside of the major metropolitan areas of Louisville, Lexington, and greater Cincinnati, Kentucky is composed of smaller cities and towns and rural areas. As a result, private providers have been slow to deploy broadband in those areas. The customer base, and housing density, is not there to entice the large privately-owned companies to come to invest in infrastructure in many smaller communities. There are just too many more lucrative opportunities for large private providers in major metropolitan areas, and thus that is where they choose to make the bulk of their broadband infrastructure investment.

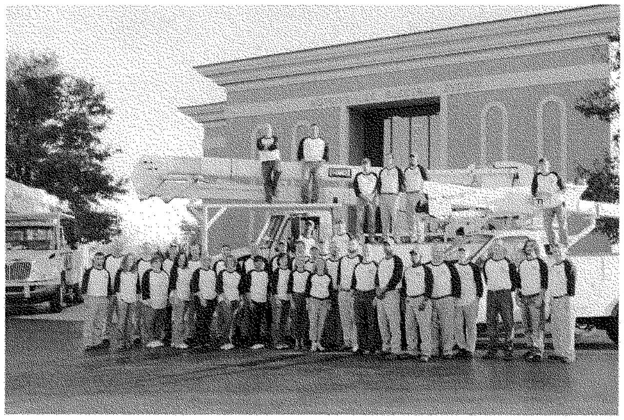
Outside of Louisville, Lexington and the greater Cincinnati area, commercial grade broadband connectivity is not available to many of the rest of us in Kentucky. As a result, smaller markets – Henderson, Frankfort, Owensboro, Barbourville, Paducah, Bowling Green, Russellville, Hopkinsville, Murray, Glasgow, and others – have to engage in "self-help." Those communities look to their municipal utilities to provide them with the same level of broadband connectivity as the Atlanta, Nashville and St. Louis markets.

Let me provide you with a few examples of municipal broadband success stories in Kentucky.

Hopkinsville, Kentucky.

In May of 1998, our Hopkinsville Electric System (HES) Board of Directors agreed to run fiber optic cable to HES substations to implement automated substation monitoring as an electric outage prevention measure. By March of 1999, we had connected our substations and ringed our City with fiber optic infrastructure and it was lit for the first time. Exhibit 3, below, is a picture of HES and some of its staff.

EXHIBIT 3



At that time, broadband service was not available in Hopkinsville. Recognizing the need for our community to participate in the global economy and have available all educational opportunities, HES elected to use our fiber infrastructure to provide broadband as a service to local businesses, industries, governmental entities and others needing high-speed data communications. An HES subsidiary, EnergyNet, was created to manage the telecommunication and broadband side of HES operations. Bandwidth at reasonable rates quickly became a popular commodity in our community.

Kentucky Derby Hosiery, an international sock company, was our first customer. After that, all city buildings -- including the emergency operations center, fire stations and police stations -- were connected. All schools were connected as well, and by becoming a USAC-approved provider of E-Rate services, we were able to reimburse the school system 80% of its costs for connectivity. Most major businesses in town are now connected over our fiber optic network and purchase our Internet service.

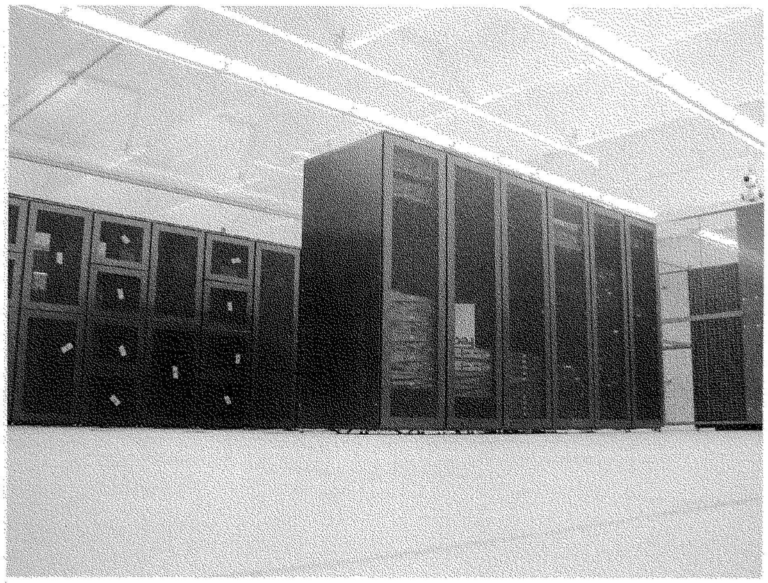
In late 2006, the HES board made the decision to provide the residents of Hopkinsville with locally-owned, reliable, affordable broadband Internet service. This was accomplished by deploying a wireless "mesh" broadband network throughout Hopkinsville using our fiber for backhaul. In addition to providing Hopkinsville residents with broadband Internet service, the network would later be used to read our smart meters remotely, using the latest automated meter reading technology. Also, the wireless network provides the Internet connections for over seventy city police and other emergency vehicles.

Thus, our last-mile broadband service in Hopkinsville is provided through a combination of fiber optic and wireless transmission. In the end, it is my opinion that this combination is probably the most effective broadband delivery mechanism for rural America's last mile.

As EnergyNet continued to grow and add both residential and commercial customers, HES management realized the need to deepen the level of support and security provided for critical services of our business and public sector customers. In November of 2006 the decision was made to build a new network operations center. Exhibits 4 and 5, below, are pictures of the exterior and interior of the HES network operations center.

EXHIBIT 4

EXHIBIT 5



This new, hardened facility, completed in 2008, was designed from the ground up to be state-of-the-art and to provide EnergyNet and its customers with a secure, stable environment in which to house critical network operations equipment as well as customer equipment and data. We now host server equipment for local businesses, the hospital, and other anchor institutions and provide points of presence for three long distance companies.

Before we had a long distance carrier point of presence (POP) in our community, we were severely handicapped in our ability to buy wholesale bandwidth at the reasonable prices that were available in larger cities. So, in 2008, our Board, with a lot of community support, committed to constructing a fiber optic transmission line to the Qwest Communications POP in Bowling Green, Kentucky, seventy miles to our east. This line was constructed as a fiber optic ground wire that rides on the top of the Tennessee Valley Authority (TVA) steel tower electric transmission line between Hopkinsville and Bowling Green. Exhibit 6, below, is a helicopter and crewman attaching the fiber optic ground wire to the TVA steel tower electric transmission line.

EXHIBIT 6

The ability to purchase wholesale bandwidth directly from Qwest Communications reduced our bandwidth cost from $125 per megabit to $20 per megabit – an 84% reduction. We pass these savings along to our customers, along with the strong reliability of a steel-tower-built line. Not only do we use this line to purchase our bandwidth needs; it is also used to supply the bandwidth needs of our local private cable TV company, New Wave Communications. Plans are underway to connect the line to Russellville and Elkton, Kentucky, to our east.

In addition, HES leases a secondary line from AT&T that links us to Nashville, Tennessee, where we purchase wholesale bandwidth from Level 3 Communications. This provides us with a secondary backbone connection for security and reliability. This second leased line is also used to share reasonably priced wholesale bandwidth with Clarksville, Tennessee, another municipal electric system 20 miles to our south.

During the 2009 ice storm in Kentucky, the worst natural disaster in our state's history, Hopkinsville suffered significant damage. Even though approximately 30% of our electric customers were without power, whole cities were blacked out to the north and west of us. We are proud that our broadband system, early in the disaster, was practically the only communications system that stayed up and working and was a very valuable emergency tool in the recovery efforts.

Through the efforts and foresight of dedicated HES Board members and staff over the last 12 years, today our small town is on the national map of "connected cities." Today, we can offer the same amount of bandwidth at prices that match those of major cities. Infact, we have an industrial site that is in the running for identification by the Deloitte Company and TVA as a pre-certified data center site. This means we have the connectivity, electric power, available land and location to attract a major data center such as Google, Peak10, Microsoft, and the Department of Defense, among others which could bring good-paying, new economy jobs to our community. Thus, we are not only providing a tool for our existing businesses and citizens, but an economic development tool for our community to bring in new businesses.

Although we are proud of our "connecting-our-community/last-mile history," our story is not unique. Other municipal electric systems in Kentucky have similar stories, and so do other municipals around the country.

In Kentucky, the nearby cities of Murray, Mayfield, Paducah, Princeton, Russellville, Bowling Green, and Glasgow are working with us in connecting transmission fiber and network operations centers into a regional network to provide greater security, redundancy, efficiency and marketing capability. Our vision is to eventually connect all the municipal broadband utilities in Kentucky for the benefit of our customers and citizens of our Commonwealth.

Locally, our work is not done, however. We are branching out to the more rural areas of our county with our wireless network as we develop the cash flow to do so. Neighboring Todd County has also asked our assistance to bring broadband to their community. There, the school system received a grant to give each high school student a laptop, but they do not have a broadband service to connect them to. Also, our City does the emergency dispatching for Todd County, and they need a high speed connection to their police department. Thus, we are planning a fiber route through Elkton, the county seat, to help them get started.

But "just like a turtle you find sitting on a fence post, you know he didn't get there by himself." So it is with us. We have been successful due in no small part to the help of our business partners and associates. We owe a debt of gratitude to Qwest Communications, AT&T, Level 3, the Tennessee Valley Authority, New Wave Communications, Cinergy Communications and certainly our fellow KMUA/APPA members.

Frankfort.

When the incumbent telephone and cable companies in Frankfort would not expand their networks in Frankfort to provide Internet service outside of the downtown area, the Frankfort Plant Board decided to provide broadband, because the citizens wanted it, demanded it and needed it. Much better than the state or national average, a full 55% of households in Frankfort now have Internet service provided by the municipal utility. This is what economic development officer, Phil Kerrick, has to say about the impact that Frankfort Plant Board's broadband has had on economic development: "Frankfort has long been on the cutting edge of communications technology. Cable television came to Frankfort in the early 1950s, nearly a quarter century before most other communities. The Frankfort Plant Board, a municipal utility provider of water, electricity and telecommunications services, was first to bring cable television to Frankfort and is now providing the same telecommunications technology in broadband as the national companies at competitive rates. This makes us very attractive as a place to come and do business for prospective businesses and industries."

Barbourville.

Barbourville purchased the existing cable television system in August of 1996. At that time, there was no Internet available anywhere in the county. Barbourville's utility began offering dial-up Internet service in the summer of 1997 by partnering with Union College. Barbourville utility started offering broadband cable modems in the early spring of 1998, becoming one of the first places in Kentucky to offer the service. In January of 2000, Barbourville was named one of the "Most Wired Cities in America" by Yahoo Internet Life magazine. There were eight cities profiled, and Barbourville was by far the smallest. In October of 1999, Barbourville's broadband system helped the city recruit DataTrac. Barbourville was chosen over several other cities, including Houston, Texas. DataTrac does contract call center work for the federal government. Initially, DataTrac provided call support for the Immigration and Naturalization Service, but it is currently providing services for the Federal Bureau of Investigation.

Barbourville's utility provides fiber-optic connections for nine out of the eleven of the county schools. Other local businesses have connections and services that they could not otherwise get if it were not for the Barbourville utility's broadband network.

Since 1998, Barbourville's utility has not increased its price for broadband. In fact, the utility has reduced its prices on broadband while providing faster speeds. In a county where nearly half of the population does not have a high school diploma, Barbourville's utility provides broadband services to approximately forty percent (40%) of the customers that subscribe to its cable television service.

Bowling Green Municipal Utilities (BGMU).

BGMU purposely invested in a full and complete fiber loop around and through Bowling Green. BGMU's commercial customers enjoy the benefits of stable, reliable and robust fiber connections, with local service personnel they know and can call. Western Kentucky University connects its outlying campuses together by leasing dark fiber from BGMU. The City of Bowling Green has implemented for its own public safety needs (police and fire) a wi-fi system with rich and complete backhaul provided through BGMU fiber. BGMU's system fulfills a role to make Bowling Green viable and economically competitive.

Buddy Steen, Executive Director of the Innovation and Commercialization Center, and the Center for Research and Development at Western Kentucky, had this to say about the BGMU fiber network: "BGMU continues to be critical for us to develop the Business Accelerator program at the Western Kentucky University Center for Research and Development. When BGMU fiber was installed at our facility, it was like transitioning from a 'ghost town' to a 'metro downtown.' This place lit up like a Christmas tree. Since the BGMU fiber installation, one of our Accelerator Program tenants grew from two to nearly 50 employees because of the difference it made in their business. They even moved their Computer Data Center from a network operations center in California to their offices here in Bowling Green."

Murray Electric System.

Murray Electric System entered the broadband telecommunications business in Murray early in 2000. As it became obvious that advanced telecommunications services, specifically high-speed Internet service, were becoming a necessity for business and industry, and a prized infrastructure for recruiting new business and industry, Murray's Mayor and council encouraged the City-owned Electric System to investigate venturing into broadband services.

A feasibility study was commissioned, which included institutional interviews with City and County government, the local hospital, large industrial customers, and Murray State University. The overwhelming consensus was that yes, Murray Electric System should step in and build and provide broadband infrastructure to the community. At that point in time, no private provider was delivering these services, nor had they announced any intention to do so.

Today, Murray Electric System provides cable television service, which includes digital and high-definition capabilities, to over 3,500 homes. This is well over 50% of the homes that the utility passes with its cable plant. In addition, the utility provides high-speed Internet services to over 2,700 homes and businesses. A private cable operator also offers these same services, although ownership of this company has changed hands three times since Murray Electric System entered the marketplace. The average cable subscriber in Murray saves an average of $20 per month compared to those who live in towns without competition.

Murray's broadband infrastructure was built with funds from revenue bonds issued in the amount of $13.75 million. Those bonds are being serviced with the revenues produced by the sale of cable and broadband services. There is not, nor has there ever been, any subsidization from tax revenues, nor did electric sales revenue intermingle with the utility's broadband operation.

In 2005, in partnership with the Murray-Calloway Economic Development Corporation, high-capacity fiber optic cable was extended into the Industrial Park situated on the north side of Murray. Services derived from the fiber were a definite benefit in attracting the new Webasto plant to Murray. According the Mark Manning, the EDC President, these services are as vital to economic development as water, sewer, and electricity.

* * * * *

There are many other municipal broadband success stories to be told. My basic point is this: The nation's municipal utilities have been on the forefront in bringing broadband to the homes and businesses of our nation's smaller communities and rural areas. We hope that Congress will continue to recognize and support those efforts.

Thank you for allowing me to testify here today. I look forward to your questions.

Mr. BOUCHER. Thank you, Mr. Carroll. Mr. Eisenach.

STATEMENT OF JEFFREY EISENACH

Mr. EISENACH. Mr. Boucher, Mr. Stearns, members of the subcommittee, thank you for having me here today. I will move quickly to stay on time. The first point I would like to make is that America's current broadband policies are by and large succeeding. Availability is increasing, prices are falling, adoption is rising, and high rates of investment and innovation ensure that these trends will continue. Our policies can be improved and the National Broadband Plan contains some good ideas for doing so, but we could also make things worse, in particular, by imposing radical and unwarranted new regulations. I will circle back to these policy issues in a minute, but first let me describe what I consider to be some clear indicators that our broadband policies are producing good results.

I have got some slides. We can go ahead and put the first one up. First, as the National Broadband Plan itself points out, approximately 19 out of 20 American households have access to one or more wireline providers today, and even more, all but about 2 percent have access to one or more providers offering 3G wireless services. Second, and as the next slide shows, broadband prices are dropping and speeds are increasing. Most importantly, from the perspective of broadband adoption, the price per megabit for entry level plans has fallen by about 75 percent since 2004. I will pause for a second and emphasize the price of entry level broadband services per megabit in the United States has fallen by 74 percent in the last 5 years. That is a success story.

Third, as the next slide shows, broadband adoption in the U.S. has reached nearly 70 percent of households and is continuing to expand, and as the next slide shows, and, importantly, adoption is rising most rapidly in the demographic groups where it has been lowest in the past. With adoption rates rising by 58 percent among those aged 65 or above, 40 percent for low income households, and 21 percent for rural households between 2008 and 2009. Now these positive results, as the next slide suggests, are a function of the high levels of mainly private investment of America's broadband infrastructure. Between 2008 and 2014 analysts estimate that private firms will invest over $450 billion in America's communications infrastructure of which more than half, $244 billion, will be dedicated to broadband.

In fact, as the next slide indicates, perhaps the strongest indicator that our broadband policies are working lies in the fact that investment and communications equipment has performed quite strongly even during the recent recession. Whereas private fixed investment overall is down nearly 25 percent since 2006, investment in communications equipment is up by nearly 10 percent. These data are important because they refute the story line some interest groups are pushing which is that our policies have failed and are in need of radical change in the form of massive new regulatory schemes known as Net Neutrality and mandatory unbundling. Complete discussion of these issues would take more time than we have here today, but let me be clear about this. Whatever else one thinks about these proposals, there is simply no question that they would reduce investment and slow deployment of broadband infrastructure, which is what we are here talking about today.

Now let me turn to the National Broadband Plan's proposal for expanding broadband availability and reforming the universal service program, the thrust of which I strongly support. In particular, the commission is in my view absolutely right to focus universal service subsidies on areas where there is not in the absence of a subsidy a viable business case for private sector deployment. That is, areas which would otherwise be unserved. Further, the commission's proposal to save about $15.5 billion by phasing out funding to competitive eligible telecommunications carriers and reducing funding to other high-cost programs are long overdue.

I would also suggest the commission take a hard look at areas where cable firms offer unsubsidized voice service. If a cable company can offer telephone service at reasonable rates without a subsidy then a phone company ought to be able to do so as well. My own research suggests the commission could save another $6 billion to $10 billion over the next decade by simply eliminating subsidies to telephone companies where unsubsidized cable companies are providing service in the same areas. The commission also, in my view, needs to take out a sharper pencil when it comes to new spending. Its estimate of a $24 billion availability gap is based on 2 assumptions that deserve a very hard look. First, this figure apparently assumes that 4G wireless deployment will not count as meeting broadband availability goals even though the commission says it believes 4G systems will cover 5 of the 7 million currently unserved housing units.

Second, it also assumes that we will extend terrestrial broadband capacity to the 250,000 most costly to serve housing units in the U.S. for a total cost of $14 billion. That is an average of $56,000 per housing unit. Is that something we are really going to do? It may be more than the houses are worth. When these factors are taken into account, it would appear that the broadband availability gap is far smaller and the opportunity for savings from current USF programs is far greater than the plan currently suggests. And this suggests in turn, to go to my final slide, that the plan's current objective of merely not increasing the USF contribution factor, which as this slide shows, stands at an all time high of 15.3 percent, is not sufficiently ambitious.

Let me close by complimenting the commission on its commitment to a data-driven fact-based approach to policy making and by urging it to continue that approach as it moves forward. As a start, I know we are all anxiously awaiting the release of the underlying analyses upon which the plan's recommendations are based, and I gather some of those may have been released, at which point it may make sense to revisit much of what is being discussed here. Mr. Chairman, that completes my opening remarks. I look forward to your questions.

[The prepared statement of Mr. Eisenach follows:]

TESTIMONY

OF

JEFFREY A. EISENACH, PH.D.

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY AND THE INTERNET

COMMITTEE ON ENERGY AND COMMERCE

UNITED STATES HOUSE OF REPRESENTATIVES

April 21, 2010

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss issues relating to the deployment of broadband communications networks.

I have had the opportunity to study communications and broadband policy issues over the course of many years, and in several capacities, including in my current positions as a Managing Director at Navigant Economics, an adjunct professor at George Mason University Law School, and a member of the Advisory Board of the Pew Project on the Internet and American Life. I should note that, while my consulting practice often involves issues relating to communications and broadband policy, I am appearing today solely on my own behalf.

If there is one primary message I hope you will take away from my testimony today it is that America's broadband policies are succeeding. They are succeeding in increasing broadband availability, succeeding in reducing broadband prices, and succeeding in increasing the proportion of the population that chooses to purchase broadband at home. They are incentivizing high levels of investment, and generating rapid innovation in every sector of the Internet "ecosystem," from networks and devices to content and applications.

I know you sometimes hear otherwise. Various interest groups – and sometimes even government officials – have taken to talking down America's broadband success as a means of justifying their proposals for radical changes in telecommunications policy. There is plenty of room for improvement in U.S. broadband policy, but that improvement consists mainly of expanding upon the market-based approach that has defined our policy for more than a decade.

Today, I would like to briefly cover two broad topics. First, I want to present just a few facts and statistics about the state of broadband in America, to illustrate the basis for my belief that our current policies are, by and large, succeeding. Second, I will briefly address four policy issues that relate directly to broadband deployment: Network Neutrality; Wholesale Competition; Allocation of Wireless Spectrum; and, Universal Service.

The FCC's Omnibus Broadband Initiative, and the resulting National Broadband Plan, undoubtedly represent the most thorough and intensive analysis of communications policy ever undertaken in the U.S., or, perhaps, anywhere. I salute Chairman Genachowski, as well as OBI Executive Director Blair Levin and everyone who worked on the plan, for producing a tremendous amount of useful data and substantive analysis in a very short time.

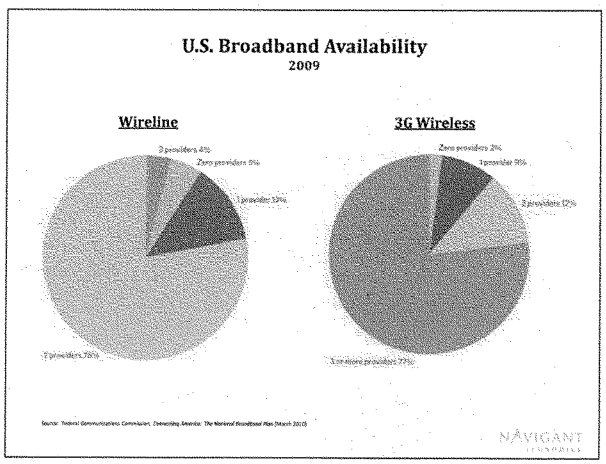
A careful reading of the analysis presented in the Plan, and of the large and detailed record that supports it, supports the conclusion that U.S. policies have accomplished a great deal over the past several years, and that progress is likely to continue unless it is interrupted by adoption of excessive and unnecessary regulation.

As the Plan itself concludes,

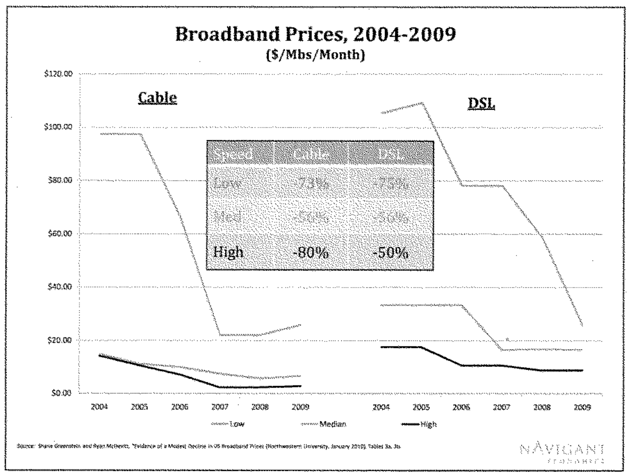
> Fueled primarily by private sector investment and innovation, the American broadband ecosystem has evolved rapidly. The number of Americans who have broadband at home has grown from eight million in 2000 to nearly 200 million last year. Increasingly capable fixed and mobile networks allow Americans to access a growing number of valuable applications through innovative devices. (National Broadband Plan at xi.)

Let me emphasize just a few facts that demonstrate what we have accomplished and what can reasonably be expected in the near future.

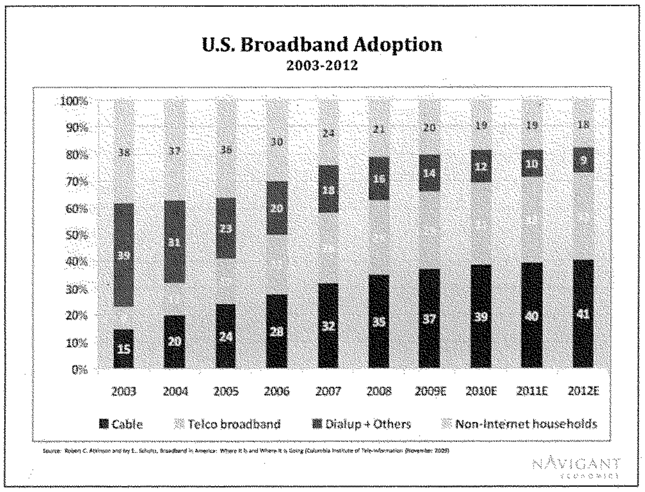
First, in terms of broadband availability, the National Broadband Plan reports that approximately 95 percent of U.S. households have access to wireline broadband service today, and the vast majority of those have access to two or more providers. (National Broadband Plan at 37.) Moreover, 98 percent of Americans live in areas served by 3G wireless services, and the vast majority of these have access to three or more providers. (National Broadband Plan at 39.)



Secondly, the data also demonstrate that broadband prices are falling and, arguably, falling very rapidly. A study prepared as part of the National Broadband Plan utilized hedonic price indices to conclude that broadband prices are falling "modestly" – i.e., between 3 percent and 10 percent over the past five years. (Greenstein and McDevitt at 1.) While such measures have their place, the simple fact is that broadband prices as measured by *price per megabit* are falling much more rapidly. As shown in the figure below, actual prices per megabit have fallen by between 50 percent and 80 percent in the last five years. Moreover, and importantly, prices for entry-level services have fallen by between 73 and 75 percent.



Third, as a result of nearly ubiquitous availability and rapidly falling prices, broadband adoption in the U.S. is high and rising rapidly. As shown in the figure below, approximately 70 percent of U.S. households will subscribe to broadband by the end of this year, and that figure will rise to 74 percent by 2012 – just two years from now. (CITI Report at 26.)



Moreover, and importantly, broadband penetration is rising most rapidly in demographic groups where adoption has heretofore lagged behind. As shown in the figure below, Internet penetration is growing rapidly among older Americans, those living in rural areas, and those with lower incomes.

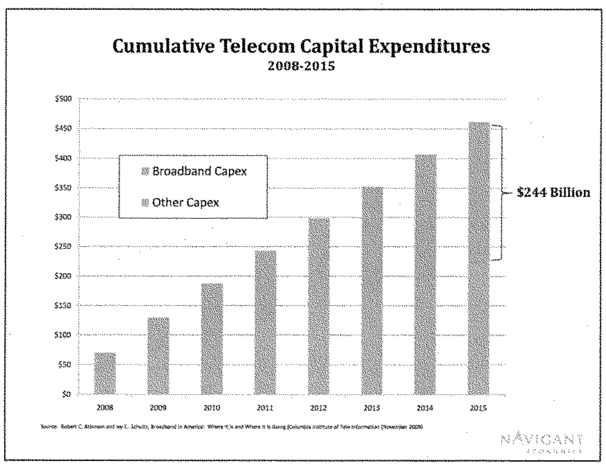
Increases in Broadband Adoption
2008-2009

	Percentage Point Change	Percent Change
Age		
65+	11	58%
50-64	11	22%
30-49	3	4%
18-29	7	10%
Location		
Rural	8	21%
Non-Rural	8	13%
Income		
Under $20K	10	40%
$40-50K	11	18%
Over 100K	3	4%

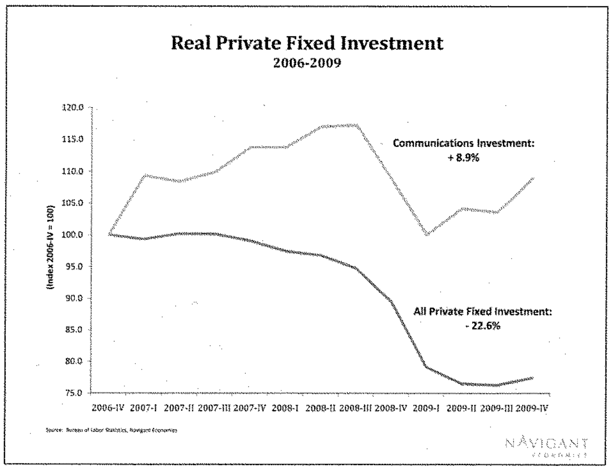
Source: Pew Project on the Internet and American Life, 2009

NAVIGANT

Fourth, all of this progress has been enabled, ultimately, by the high rates of investment our current broadband policies have produced. Industry analysts estimate that broadband providers will invest approximately $30 billion annually in broadband networks each year between 2008 and 2015, or a total during that eight-year period of more than $240 billion. (CITI November 2009 Report at 66.)



In fact, one measure of the success of our current policies is the extent to which investment has held up despite the deep economic recession. As shown in the figure below, real private fixed investment in the economy overall began declining in 2006, and remains roughly 23 percent below its late 2006 levels. Investment in communications equipment, by contrast, continued increasing through 2007 and 2008, and while it declined sharply in early 2009, it has resumed its prior growth trend and remains more than 9 percent above its 2006 levels. The continuing improvement in our broadband infrastructure is among the reasons the high-tech sector is leading the economy out of recession.



Finally, the most encouraging conclusion to emerge from the National Broadband Plan is the fact that all of the positive trends detailed above are likely to continue. In particular, the Plan notes the dramatic improvements in wireless broadband services – both satellite and terrestrial – on the immediate horizon, and suggests there are good reasons to believe that wireless broadband will soon emerge as an effective competitor to wireline. (National Broadband Plan at 40-42.)

To summarize this first part of my testimony, the evidence clearly demonstrates that U.S. broadband policies are yielding increasing availability, lower prices, rising adoption, and high levels of investing and innovation that bode well for the future. The evidence, in other words, does not support radical change in our current policies.

And yet, radical change is precisely what some would like to see – and, in certain areas, what the Commission has proposed.

First, last year, the Commission issued its *Notice of Proposed Rulemaking in the Matters of Preserving the Open Internet and Broadband Industry Practices* – the Net Neutrality rulemaking. Last week, I was among 21 economic experts who filed a declaration in those proceedings in which we stated our strong opinion that the economic evidence does not support the Commission's proposed rules. Indeed, and I quote, we advised the Commission that "it is extremely likely that the regulations proposed in the NRPM would harm consumers and competition and reduce economic welfare." (See Attachment A.)

Second, the National Broadband Plan alludes to the possibility of reversing more than a decade of Commission policy relating to wholesale unbundling of broadband infrastructure, suggesting specifically that the Commission should act on a petition for rulemaking by Cbeyond, Inc. that would impose forced access regulations on fiber-to-the-home and fiber-to-the-cabinet infrastructures. (National Broadband Plan at n. 75.)

In support of its petition, Cbeyond argues that unbundling regulation does not reduce carriers' incentives to invest in infrastructure, a thesis that has also been advanced in recent studies by Harvard's Berkman Center and Free Press. In addition, Cbeyond and others have sought to inject partisanship into the debate, suggesting that the decision to forebear from unbundling broadband services was made in the early 2000s – that is, under the Bush Administration.

The Subcommittee should know two things. First, as I detailed in a joint declaration to the FCC late last year (see Attachment B), empirical studies of the effects of unbundling regulation leave little doubt that it has reduced investment and ultimately led to lower levels of broadband penetration. Indeed, the National Broadband Plan itself cites new empirical analyses demonstrating that *infrastructure-based competition* between wireline providers increases investment. (National Broadband Plan at 38.)

Second, the decision not to impose unbundling regulations on broadband was made, in the first instance, not by Chairman Powell or the Bush FCC, but rather by Chairman Kennard, in 1999. Faced with demands to impose open-access on cable modem services as condition in the AT&T-TCI merger, Chairman Kennard refused to do so. His September 1999 explanation is worth keeping in mind today:

> It is easy to say that government should write a regulation, to say that as a broad statement of principle that a cable operator shall not discriminate against unaffiliated Internet service providers on the cable platform. It is quite another thing to write that rule, to make it real and then to enforce it.... So, if we have the hope of facilitating a market-based solution here, we should do it, because the alternative is to go to the telephone world, a world that we are trying to deregulate and just pick up this whole morass of regulation and dump it wholesale on the cable pipe. That is not good for America.[1]

More than a decade later, the market-based solution Chairman Kennard envisioned has in fact come to fruition. There is simply no basis for the Commission to revisit the question of whether to impose "the whole morass" of unbundling regulation on broadband providers.

While I strongly oppose the Commission's proposals to drastically expand regulation of broadband networks, there are other areas where the National Broadband Plan has proposed sensible steps in the direction of important reforms. Let me mention two of them.

First, the Commission's focus on spectrum policy is highly commendable. Economists have been arguing for more than 50 years that spectrum licenses should be more flexible and more easily subject to voluntary reallocations among licensees – that is, that market forces should be allowed to play a greater role. Beginning in the early 1990s – and, again, on a bi-partisan basis –

[1] William E. Kennard, "Consumer Choice Through Competition: Remarks Before the National Association of Telecommunications Officers and Advisors, 19th Annual Conference," (September 17, 1999) (available at http://www.fcc.gov/Speeches/Kennard/spwek931.html).

policymakers have moved gradually to adopt these recommendations, first by allocating spectrum through the use of auctions and, later, by taking tentative steps to create more flexible licenses and workable secondary markets.

The National Broadband Plan potentially represents a significant move forward, explicitly calling for steps to increase spectrum flexibility and to speed the development of secondary markets, as well as supporting the so called "Spectrum Inventory" proposal. (National Broadband Plan at Chapter 5.) On the other hand, the Plan's proposal to "repurpose" 120 Mhz of spectrum currently licensed for digital broadcasting seems to *accept* as a starting point the notion that it takes a decade or more to reallocate – from which it concludes that the solution is to get started as soon as possible.

I respectfully suggest that the real problem is not that we are starting too late, but rather that *a decade is too long*. Rather than trying to engage in a one-time repurposing exercise (which would, indeed, take a decade or more), the Commission would do better to focus on implementing reforms that would allow spectrum to move dynamically – that is, continuously – to its highest valued uses, in response to changes in markets and technologies.

Universal service is a second area where the National Broadband Plan is on the right track. Most notably, the Commission's recommendations that the new Connect America Fund be limited to funding areas where there is no private-sector business case for providing unsubsidized broadband service, and that funding in such areas be limited to a single provider, represents an economically sound and fiscally prudent approach. My own research has demonstrated that the Universal Service Fund pays hundreds of millions of dollars annually to carriers where it is clear no subsidies are required. (See Attachment C.) If those dollars can be re-directed to supporting the investments required to extent broadband infrastructure to truly high-cost communities, we will speed up significantly the pace at which fast broadband is made available to the remaining five percent of U.S. households.

For the most part, the National Broadband Plan takes a fact-based, analytical approach to assessing the state of broadband deployment in the U.S. The evidence it presents strongly supports the need for continued reforms in areas such as spectrum flexibility and universal service. The evidence also shows that a radical departure from the market-based approach of the past decade is not called for, and why proposals to dramatically increase regulation would do far more harm than good.

* * *

Mr. Chairman and Members of the Committee, that completes my testimony. I look forward to any questions you may have.

Mr. BOUCHER. Thank you very much, Mr. Eisenach, and thanks to all of our witnesses for sharing their views with us here this morning. I was very pleased to note that the broadband plan endorses expanding the Community Connect program. And I was glad to hear you testify about that, Mr. Villano, during your presentation. Community Connect, I think, has done a terrific job in making broadband available in communities that for whatever reason the private sector has found it to be uneconomic to serve. Oftentimes these are remote communities where the cost of providing the middle mile connection in order to bring broadband into that community is prohibitive for the private sector when considering the number of subscribers who might be there to pay for those very large costs.

And Community Connect has filled that gap very well. The problem is the program, as useful as it is, only had $13 million to spend for the entire country in the course of the last year. I have seen the benefits of that program in my district. I was glad to hear Mr. Welch mention in his opening statement that the program has benefitted Vermont, and I know it has benefitted other countries. The broadband plan endorses it and says it ought to be expanded. Can you suggest, Mr. Villano, ways in which that could be done, and specifically let me begin by asking you if there are currently any statutory limitations on your ability to expand it apart from just having adequate appropriations? In other words, if more money were appropriated for this program could you spend that or would you have to have some amendment to your authorizing statute in order to enable you to do so?

Mr. VILLANO. Thank you, Chairman Boucher. No, I don't believe that there are any statutory impediments to increasing the funding for the program. A lot of what we are doing under the broadband initiative program through the Recovery Act serves a lot of these same unserved communities, so there isn't anything statutorily that would do that.

Mr. BOUCHER. And do you have the capability should additional appropriations be provided for Community Connect to spend those funds effectively?

Mr. VILLANO. I definitely believe so, that we have that capability. We are delivering $2½ billion through the Recovery Act right now. Once we get through those funds, we would be more than able to handle an increase in any appropriation under Community Connect.

Mr. BOUCHER. Is the methodology of Community Connect in any manner assisting you in expending your broadband funds through the stimulus program?

Mr. VILLANO. We have many tools in our toolbox. We have our existing broadband program, the Farm Bill program, our infrastructure program, so certainly many of the lessons that we learned in Community Connect were brought forward to the broadband initiatives program. And if we do receive increased appropriations for Community Connect, we would want to look at some of the requirements that we do have for the program.

Mr. BOUCHER. Thank you very much. I appreciate that. I think there is a general consensus on the part of most of the witnesses today that the 95 percent estimate that the broadband plan makes about the availability of broadband nationwide is somewhat optimistic, and that number in all likelihood is lower than that. What can we do to get better data than the commission had when it made that projection? Mr. Turner, you alluded to some possible approaches. Would you like to expand on that?

Mr. TURNER. Certainly. Mr. Chairman, right now the FCC collects very, very detailed subscribership data broken down by speed tier, residential versus business from every single broadband provider in the country and they collect that twice a year, and they have been collecting such data, similar data, for almost a decade now. But during that process, they have failed to actually ask the service providers please define your service territory areas and tell us what quality services are available where. And this is a much easier effort than filing the subscribership data every 6 months because basically once they define their service territory they only need to go back and change that when their service territory changes.

So in 2008 the FCC made a decision, a tentative decision, to collect such data but that was never acted upon, and it sat on the table for the past 2 years. And I think it was rather unfortunate because had they acted then, we might not have had to run the BTOP and BIP program in the dark the way we did.

Mr. BOUCHER. And so what immediate steps would you recommend?

Mr. TURNER. I believe the record is quite complete on this issue of availability data, and I think the commission should immediately move to an order on the issue and reform form 77 to require service providers to detail their availability in service quality areas.

Mr. BOUCHER. Does anyone else have comment on that? Ms. Gillett, would you like to comment or would other witnesses care to comment on what kinds of approaches we might take in order to obtain better data on the extent of real availability? Mr. Garcia.

Mr. GARCIA. Mr. Chairman, I think it is important to know if when we speak percentages we got to have a baseline number to get that percentage so when we say 95 percent, 90 percent, the three A's that we all have to keep in mind are accessibility, affordability, and availability. They could really muddy up the statistics that we provide, but I think if we don't know how many families, for instance, in our rural area, if we don't know how many families could have that service and we only take data on the one that has service there is no way to gain a percentage and so the percentage number of serviced areas would be fictitious. So I think it is important to realize that the data gathering concept ought to be kind of re-evaluated and look at how can we best get the data.

Mr. BOUCHER. All right. Thank you. Mr. Dankberg.

Mr. DANKBERG. Yes. The other thing I would add is that one of the points in the FCC National Broadband Plan was that the actual speeds that were delivered are in many cases much lower than the advertised speeds, and in order to collect this data and make it useful it seems like the size of just the availability of broadband there ought to be some definition of what that service actually is besides just the advertised speed.

Mr. BOUCHER. All right. Thank you very much. My time has expired. The gentleman from Florida, Mr. Stearns, is recognized for 5 minutes.

Mr. STEARNS. Thank you very much, Mr. Chairman. Mr. Dankberg, I just appreciate your Will Rogers quote. I am reminded of another quote that Will Rogers said is be thankful that we are not getting all of the government we are paying for, which I think goes to my question to you. You are saying today that you don't need a subsidy. You don't think we need a subsidy to go ahead and push broadband.

Mr. DANKBERG. Yes. I think there has been a point made when we talk about unserved and underserved, and there is a lack of definition, and the thing that we would really strongly advocate is that if there were a definition of what broadband is that I believe that satellite could qualify and that we made a business of providing that level of service, whatever it is to be defined, without government subsidies, yes.

Mr. STEARNS. Ms. Gillett, you seemed to hedge a little bit on the figures here. The chairman mentioned that he thought the figures were too optimistic and I think in your opening statement you talked about that, in fact, the figures could be wrong, and I think you went ahead and talked about new figures which would indicate that it went from 7 million households being unserved to 12 million households. Is that correct?

Ms. GILLETT. No, but almost. I wouldn't say the figures are wrong. I would say the figures are all of necessity estimates because we don't have perfect data about any of this and that is one of our goals is to improve the data about it.

Mr. STEARNS. In your opening statement, though, I think you actually used some figures here that we wrote down.

Ms. GILLETT. Yes. The figures are that we approached size in the gap from 2 directions. We tried 2 different methods to reach both imperfect types of data. One of them is a model and that tells us 7 million households——

Mr. STEARNS. Not so much the process, I am just saying quoting your data I still get——

Ms. GILLETT. 14 to 24.

Mr. STEARNS. Yes. I still get about 92 percent of Americans——

Ms. GILLETT. That is right. That was what I said in my testimony.

Mr. STEARNS. So the bottom line is that is a pretty good figure still.

Ms. GILLETT. It still means 24 million people without any broadband service.

Mr. STEARNS. But I think Mr. Dankberg is saying that maybe some of these people are not in the rural areas, that they are in areas that are in urban areas, which is going to what his original statement was from Will Rogers. Another question for you is that——

Ms. GILLETT. I don't disagree with him on that.

Mr. STEARNS. OK. In my opening statement, I talked about in the year 2000 there were 8 million people that had broadband and 10 years later there is 200 million. Isn't it possible that, and this is a question, I am just going to go down all, is it possible based upon those figures if we are going from 8 to 200 million that without any government doing anything in the next 10 years by the year 2020 that we will have complete universal ubiquitous broadband? Do you think that is true without any government? Just yes or no.

Ms. GILLETT. No, I don't.

Mr. STEARNS. Do you, Mr. Villano?

Mr. VILLANO. No, I don't.

Mr. STEARNS. And Mr. Garcia?

Mr. GARCIA. No.

Mr. TURNER. No.

Mr. DANKBERG. I think it is possible, yes. I do think it is possible.

Mr. STEARNS. Mr. Carroll?

Mr. CARROLL. No.

Mr. STEARNS. Mr. Eisenach?

Mr. EISENACH. I think we are very close with being here today so the answer is yes.

Mr. STEARNS. OK. So you folks are saying that the private market cannot go cover this ubiquitously without the government stepping in doing something except for Mr. Eisenach and Dankberg. Now I say to the rest of you, Mr. Dankberg meets a payroll, started out in his garage and built a business to $1 billion, so I would say if I put you guys all on a scale, I would say he would certainly have as much credibility as all of you on the other side of the scale just because he has done it, and I admire him for starting this company and getting to a billion dollars. And he showed us graphs that obviously there are some urban areas that don't have it, and he is saying through his video that by and large we can do it. So I think we all have to be careful to be careful that perhaps the market can do it on its own.

Mr. Dankberg, the 5 percent of homes that have no broadband access are likely in parts of the country that are high cost and low population density. So sometimes there is little incentive for private companies to deploy there so I am just being the devil's advocate with you here. Does this mean that you could still get into those through satellite broadband in these areas, notwithstanding that most companies, telephone companies and cable companies won't go in because it is so rural?

Mr. DANKBERG. Yes, all the terrestrial technologies depend on the distance between homes and some central anchor point. The good thing about satellite communications is that it is distance insensitive so the real issue is just can you economically deliver enough bits, enough bandwidth, to those people and that is really a technology and economics problem.

Mr. STEARNS. OK. Ms. Gillett, just if you could just answer yes or no. Does Section 230 make it the policy of the United States to preserve the vibrant and competitive free market that presently exists for the internet and other interactive computer services unfettered by federal and state regulations, isn't that true, Section 230?

Ms. GILLETT. I believe that is what the statute says, yes.

Mr. STEARNS. And striking the FCC attempt to regulate network management, didn't the D.C. court just explain that the statements of congressional policy can help delineate the contours of statutory authority? I think the answer is yes to that. And so I just caution the FCC, and my point is to go ahead and get involved with either Net Neutrality or ancillary authority to augment it through regulation, and that is my only point. Thank you, Mr. Chairman.

Mr. BOUCHER. Thank you very much, Mr. Stearns. The gentleman from Massachusetts, Mr. Markey, is recognized for 5 minutes.

Mr. MARKEY. Thank you, Mr. Chairman. And again let me just restate that I do believe that the FCC has the authority to be able to act notwithstanding the court decision. Obviously from 1996 after the Telecommunications Act passed all the way up until Chairman Powell, they implemented all of the provisions that created this broadband revolution. Remember, not one home in America had broadband in February of 1996 when the Telecommunications Act was signed. Not one home had it, so those changes in policy obviously had to be implemented by the FCC in order to create this new environment that makes all of this conversation even possible. So I do believe that the FCC has this authority and I ask them to explore the various means by which they can reach the point where they can implement the recommendations of the broadband plan that has been put together.

What I would like to do is to focus on the Broadband Data Improvement Act that we passed out of this committee about 3 years ago. We based it upon Connect Kentucky. How is that plan going? How is the data collection going under that law, Ms. Gillett, and is it helpful to the FCC?

Ms. GILLETT. Extremely. That program is administered by the NTIA, and they have given grants to all of the states at this point who are all collecting data according to a protocol that the FCC consulted. We provided technical consultation with the NTIA on that, and the data is coming in and the maps will start being assembled next month.

Mr. MARKEY. Now the information as you can see it at this particular stage, does it indicate that there are gaps across the country and do you think that this mapping is going to help us to move beyond kind of anecdotal to actual factual basis for making new policies here in the country?

Ms. GILLETT. I am totally certain that maps will be helpful and the data will be helpful. It is just coming to come in, so it is too early to say much about it, but I am sure it will be very helpful.

Mr. MARKEY. So we will wind up with much more specificity than we have had in the past?

Ms. GILLETT. Yes.

Mr. MARKEY. And we will be able to deal with what the chairman is talking about in terms of finding out what actually is going on in Virginia and not have it be based upon a company just sending in information without it being corroborated.

Ms. GILLETT. Well, there is an elaborate protocol for collecting the information, some of it from industry, but also one of the nice things about having states administer these grants is often there is a lot of local knowledge of people of what is actually going on in their territory and we are hopeful that that will help improve the quality of these maps.

Mr. MARKEY. OK, great. Now let me ask you about the E–Rate. Let me move over to that for a second. The FCC, you know, has been looking at expanding E–Rate, looking at after school hours as well, dealing with the reality of how children actually live their lives. Could you talk a little bit about that and the funding streams necessary to make sure that we actually deal with the real world 2010 life of a child at school in America?

Ms. GILLETT. Absolutely. One of the recommendations for the plan was to look at learning as a continuous process and not just confined to the school laws. In February the commission passed a waiver order and a proposed permanent rule change to allow community use of school E–Rate-funded facilities after hours, so that is one example. Another is that the plan discusses the use of wireless connectivity. Kindle and other kinds of electronic books require wireless connectivity. Students can take them home and that brings them broadband to the home where they may not otherwise have it, the many innovative uses we could make of the E–Rate program, and we are starting to implement exactly those proposals at this point.

Mr. MARKEY. Within a very small number of years half the children in our country are going to be minorities and we just have to deal with the fact that we need a broadband plan for all those children to give them the portable skill set that they are going to need in order to compete for jobs in our economy as it unfolds, and unless we think of the E–Rate as a flexible tool to deal with this ever expanding need for kids to have the skill set then I think, you know, ultimately it will come back to really haunt our economy, so I thank you for that testimony. And, again, I just want to come back to this point. We just can't have a national plan put together alone by a small handful of communications colossi. We need to ensure that we have a wide ranging entrepreneurial Darwinian paranoia-inducing internet world out there, broadband world, where everyone is given a shot here at providing the leadership for our country, and if we step aside and just allow a couple of companies to decide the pace at which new gadgets, new applications, who is going to have access to it, then we are going to be the losers because China, India, and other countries will just blow right past us with their plans to capture these sectors.

We just should not be looking at the outsourcing of jobs as each year goes by because the skills are here because the technologies haven't been developed here. That is our real opportunity here. That is what the National Broadband Plan gives us as a national challenge. When America has a plan, America wins. When we don't, we lose. We have not had a plan. We have dropped from 2nd to 15th in the world. We just have to implement something and we cannot delay that implementation. Thank you, Mr. Chairman.

Mr. BOUCHER. Thank you very much, Mr. Markey. The gentleman from Illinois, Mr. Shimkus, is recognized for 5 minutes.

Mr. SHIMKUS. Thank you, Mr. Chairman. I really do love this committee. We are behind Lichtenstein. I just—to remind my people keep using that or Mordova or the Netherlands. So I will be patient. Can't we get off this comparing us to Lichtenstein just for a minute? What the FCC did if you really want paranoid people competing to fill the broadband space, you need to deregulate. What the FCC did based upon the telecom bill was deregulate. They didn't re-regulate. That is what the FCC is trying to do now. What they want to do is since they failed in the courts now they want to re-regulate. They want to go back to the dial up phone so, anyway, you can see there is divergent opinions here on the committee, and I love Mr. Markey, and I learned all my interactions from him. I keep reminding him of that so when he disapproves of my line of questioning, I just learned it from the best, so it is a tribute to him.

Mr. Turner, do you believe the analysis in the broadband plan that 95 percent of the country to have access to broadband is flawed?

Mr. TURNER. If you define broadband as on or off meaning something or nothing, I think it is close to being correct. Ninety-two to 95 percent have something. If you were talking about broadband at a level that they defined it at 4 megabits per second, I think it is overstating the level of availability.

Mr. SHIMKUS. So you would say it is flawed in your second definition?

Mr. TURNER. Yes, that is right.

Mr. SHIMKUS. Do you believe the FCC currently lacks adequate information on the actual state of broadband availability?

Mr. TURNER. Yes, I do.

Mr. SHIMKUS. Do you think the FCC should collect better data on broadband deployment?

Mr. TURNER. Yes, sir.

Mr. SHIMKUS. Then shouldn't we refrain from taking action on the broadband plan until the FCC has that data?

Mr. TURNER. Well, sir, I think if you look at the calendar of items that will be proceeding the agency is certainly one that is thorough but it doesn't move very quickly, so I think we should, yes, immediately move to start collecting that data as the proceedings and debate——

Mr. SHIMKUS. The roll out of the money. I mean this has been a constant debate that we have had since the stimulus money saying don't roll out until you know the need.

Mr. TURNER. Well, I agree, and I think if you look at the calendar they probably won't be spending a single dollar of new USF money on the new broadband Connect America fund at least until 2012.

Mr. SHIMKUS. But that is USF money. There are millions of dollars going out the door right now, billions.

Mr. TURNER. It is rather unfortunate that, as you said earlier, the cart was put before the horse in that case.

Mr. SHIMKUS. Thank you. Mr. Villano, you do permit grant money to be used even if the majority of households covered by a project in non-rural areas and even if they already are served by one or more providers, is that correct?

Mr. VILLANO. In our Community Connect program?

Mr. SHIMKUS. Right.

Mr. VILLANO. The area has to be totally rural and no one in that community——

Mr. SHIMKUS. Yes, I know, only in the RUS program. We have several programs in the stimulus and I am talking about era and that is kind of the connection——

Mr. VILLANO. We require that the community be unserved or underserved and we send our field staff out there before any——

Mr. SHIMKUS. Well, let us talk about Hays, Kansas for a second. You understand that the Kansas broadband map shows that all but 200 of the over 11,000 households in Hays already have broadband from one or more providers, including a small employee-owned business. Is that really a good use of government funds?

Mr. VILLANO. In Hays, Kansas, we did provide a BIP award to a Kansas-based company——

Mr. SHIMKUS. You can stop there. Mr. Garcia, is that a good use of government funds if we are providing money to providers in an area that there is already competing broadband deployment when, you know, I like the way it was put, 10 percent of the Indian tribal areas have access which means 90 percent do not. Don't you think it would be a better use of money to send that to areas where there is no coverage?

Mr. GARCIA. I believe it would, but the complexities of how these proposals are applied for is what drives the funding and where the funding is——

Mr. SHIMKUS. Well, I disagree that there are very complex at all. I would say either a person has service or they don't. Mr. Turner, you used the example of the grocery store. Either they have a defined broadband speed and they can get access to it or they don't and shouldn't we then going back to the first question know who has service before we send money to people who may have competing broadband applicants?

Mr. TURNER. I think it is absolutely for the benefits of efficiency and the benefits of maximizing the money, it is important to have the right data. However, I understand what this body was trying to do in the context of stimulus, and I defer to the collaboration judgment of this body in making that decision.

Mr. SHIMKUS. My time has expired, and that is where we disagree. I think we spent money and we put people who are already providing broadband, we empower competitors to compete against with government-subsidized dollars in the broadband field, and that is a failure of what we have done. And, Mr. Dankberg, I do support technicologically neutral in competition for services.

Mr. BOUCHER. Thank you very much, Mr. Shimkus. The gentlelady from the Virgin Islands, Ms. Christensen, is recognized for 5 minutes.

Ms. CHRISTENSEN. Thank you, Mr. Chairman. I would like to ask Ms. Gillett, having followed the Comcast case, do you anticipate that the Comcast decision of April 6 would affect your analysis of these universal service issues or the recommendations in the National Broadband Plan in any way, and if so, why and how?

Ms. GILLETT. Our general counsel is assessing the impact of the Comcast decision on our authority to support broadband by USF.

Ms. CHRISTENSEN. And, Mr. Villano, as you may have gleaned from my opening statement the U.S. Virgin Islands has not received grants under ARRA funds or broadband infrastructure. One of the things that I am concerned about is that the existing landline telephone service provider by Telcos is considered the incumbent borrower and is a troubled entity. To what extent, if any, do you think this would affect other entities in the Virgin Islands from receiving ARRA funding, the fact that the incumbent is a problem?

Mr. VILLANO. We just closed the second NOPA and there weren't any applications from the Virgin Islands for a second round of funding. I don't know the reasons why but there weren't any applications for a second round of funding.

Ms. CHRISTENSEN. That surprises me because I thought we had applied. OK. Well, also——

Mr. VILLANO. They could have applied under the NTA BTAL program for a middle mile project but there were no last mile projects under the BIP program at RUS.

Ms. CHRISTENSEN. Just to continue on the concern that Mr. Shimkus was raising. Is it true that RUS does allow grant money to be used in non-rural areas regardless of whether that area includes a majority of households covered by a project and is already served by one of the major providers, and, if so, is there an appeals process in place that one of the companies that are already there——

Mr. VILLANO. The award in question was made under our first NOFA, and we have a definition of unserved and underserved areas. In that particular case, 95 percent of the service territory had not broadband service. It was just 5 percent of the geographic area that was covered by the loan grant combination that the applicant was awarded did some terrestrial based service.

Ms. CHRISTENSEN. OK. So is there a process for appealing?

Mr. VILLANO. No, there is no process for appeal.

Ms. CHRISTENSEN. I guess I will ask you also again, Mr. Villano, will NTIA and RUS collaborate on broadband infrastructure awards and what effect will that have on applicants who have submitted multiple applications?

Mr. VILLANO. Definitely, we will continue our collaboration. We have separate NOFAs at this time. I can tell you we are in constant communication and coordinating our efforts. Under the second NOFAs, RUS is focusing on last mile and NTIA is focusing on middle mile, but we are working very closely together to make sure that we get the best bang for our buck.

Ms. CHRISTENSEN. So you are saying then that it won't have any effect on applicants that have submitted multiple applications. It will be coordinated in some way?

Mr. VILLANO. Under our first NOFA, we allowed for joint applications and it did complicate the process for some applicants. That is why we went with separate NOFAs and separate application processes go round, so we will look to make sure that there aren't any overlaps. If they are proposing to find a project and we are in a particular area, we want to make sure that we get the money to the most areas.

Ms. CHRISTENSEN. Thank you, Mr. Chairman. I yield back.

Mr. BOUCHER. Thank you, Ms. Christensen. The gentleman, Mr. Buyer, is not here. The gentleman from Alabama, Mr. Griffith, is recognized for 5 minutes.

Mr. GRIFFITH. Thank you, Mr. Chairman. The FCC, as it rolls out the National Broadband Plan in an attempt to deploy to the remaining 5 percent, are we concerned about adoption or how we are going to measure adoption rates? Is that a problem or is that a concern that we have?

Ms. GILLETT. Adoption is very important. It is a very central part of the plan as to take steps that increase the adoption of broadband. I would say that our data on adoption is actually better than our data on availability because that is what we collect is subscribership data, and we are now publishing ranges of adoption data in our semi-annual reports.

Mr. GRIFFITH. Thank you. One other question. As we look at the FCC's recommendation for deployment for national broadband, has the exemption for the electric cooperatives from FCC pole attachment regulations been considered?

Ms. GILLETT. I am sorry. Was it in the National Broadband Plan, was that issue based?

Mr. GRIFFITH. Right.

Ms. GILLETT. Yes, it was raised in the National Broadband Plan that poles are an essential—access to poles is essential for deploying broadband and there isn't a uniform national framework, and that is a congressional question for Congress to consider.

Mr. GRIFFITH. Are we suggesting that we will continue with that exemption for the——

Ms. GILLETT. It is currently part of the statute so Section 224, that is how it is set up that there are separate frameworks for how those are regulated, and that would be up to Congress to decide if that is the right framework to continue or not.

Mr. GRIFFITH. So that is really a question for me. Thank you very much. OK. Mr. Villano, the second round of broadband initiative program allocates $100 million to satellite projects to provide broadband services to unserved areas. Most U.S. satellites have a national footprint. How is RUS determining what is an unserved satellite area?

Mr. VILLANO. We will be posting maps of the service areas that we fund and NTIA funds under the broadband initiative and the BTOP program, and the satellite component, we have an RFP that will be published later this month that will make that money available. We are dividing the country into 8 regions and we will let competition dictate how we award those funds, but those would be areas that have no broadband service and not be able to receiver service under the Recovery Act.

Mr. GRIFFITH. In light of some of the data or some of the comments that we have heard today about what we believe is true and what is actually true in unserved areas are we reviewing what we think is true and what is actually true?

Mr. VILLANO. I can tell you for every award that we have made under our broadband initiative program, we send actual RUS staff out to the field to verify the information that was provided by the applicant, and we also post all the maps of the proposed service territories so incumbent service providers can comment on that whether they do provide service. We look at the comments. We look at the application. We send feet on the ground to ensure that those areas meet the definitions of the NOFA.

Mr. GRIFFITH. OK. Thank you. Mr. Dankberg, I understand that satellite broadband services offer an opportunity to reach U.S. consumers in otherwise unserved areas. When the FCC imposes conditions on license transfer applications that limit the business models of satellite operators, does that make it more difficult or less difficult to raise money to continue satellite services?

Mr. DANKBERG. The only thing I can talk about is our experience, and we have had fantastic support from the FCC in approving our licenses and being innovative in spectrum and in assuming and approving a transfer of licenses when required so it has not really been a concern. The FCC from our perspective has been very supportive, sir.

Mr. GRIFFITH. Thank you, Mr. Chairman.

Mr. BOUCHER. Thank you, Mr. Griffith. The gentleman from Pennsylvania, Mr. Doyle, is recognized for 7 minutes.

Mr. DOYLE. Thank you, Mr. Chairman. The residents and small businesses in my district in Pittsburgh have contributed to the tens of billions of dollars worth of subsidies to support telephone service in rural areas and for low income people. In 2010 these dollars are still being used for telephones, not broadband. Now the FCC has outlined a Universal Service Fund reform in the National Broadband Plan, and I would like to just start with Mr. Garcia and work down through the end of the panel. Number 1, do you support that plan, what you like about it, and how you would improve it, and if each could just do that briefly, I would appreciate it. Mr. Garcia.

Mr. GARCIA. We support the fact that the universal service has to be reformed but we also caution that the services that are part of that plan right now not be restricted or diminished but there has got to be more accountability in terms of why—that fund has been around for a long time and so why do we still have a lot of areas that have not benefitted from that very fact, and so we need to employ that a little bit harder and be more deliberate in how that service funds are used for that, so we don't want to diminish what is there, but in addition to what we just testified upon, we need to build on those opportunities so we need to keep that though.

Mr. DOYLE. Thank you. Mr. Turner.

Mr. TURNER. We are generally supportive of the framework certainly of a transition. We think it is time to modernize the fund. We do have some concerns about what is going to happen during the transition, particularly issues that Dr. Eisenach has raised that we do have areas where there are unsubsidized providers, either cable or wireless companies that are competing against the subsidized telephone provider, and that may not be the best use for our resources. We are also concerned that even some subsidized providers themselves where no other un-subsidized providers exist have already deployed broadband and could be self-sustaining if all their revenue streams are taken into account but today only the regulated streams are taken into account while the recovery and the cost of their full infrastructure, so we are concerned that the FCC should address some of those as we do the transition.

Mr. DOYLE. Thanks. Mr. Dankberg.

Mr. DANKBERG. I think the major issue that we have is the artifacts of where unserved people are in a broadband environment is much different than where unserved people are in a voice environment. We have networks that were built for voice. You can support long loop lines. That leaves by definition, that is what you seen on the map, people who are well served by voice that are not served by broadband. And so the notion that you can segregate the areas of served and unserved people like you can with voice, I think is not a good starting point for building policy.

Mr. DOYLE. Mr. Carroll?

Mr. CARROLL. The American Public Power Association doesn't have a position on that but from my position at Hopkinsville Electric System, I think broadband could be expanded by using those funds. I think we need to ensure that the different entities out there that provide services have access to those funds universally and not just the telephone company.

Mr. DOYLE. Dr. Eisenach?

Mr. EISENACH. I would just say 2 things. I think the plan doesn't go far enough fast enough as described. Talking about saving $15 billion out of 45 or so over the course of a decade implies that $30 billion during that period of time is still going to get spent on what we are spending money on now. My second point would be I think the commission has known for a decade and so has most people in Congress that this is a failed program. This docket was initiated—the docket number under which all this is considered is 9645. It was opened in 1996 and has been going on since with 250,000 or so final comments. The commission has tried heroically half a dozen times at least to reform it and it has failed. So my point to this committee would be if you want that money going to broadband you ought to keep a very close eye on the commission's success or failure in implementing these reforms as proposed.

Mr. DOYLE. Thank you. Ms. Gillett, I have heard some concerns that the Universal Service Fund reform would mean that some people's phones would be turned off. Is that the case, and if it is not the case would you state why it is or why it isn't?

Ms. GILLETT. It is not the case and it would not be the case because the plan's recommendation is that the funding should be shifted from voice only networks to networks that provide both broadband and high quality voice.

Mr. DOYLE. OK. I think that is important to get out. Mr. Dankberg, in light of what you said to Mr. Stearns, Mr. Villano from the Rural Utility Service has set aside $100 million for satellite broadband. I assume your company won't be taking a cent of that money. You are not interested in any of that money?

Mr. DANKBERG. If there is money to be made in subsidies then we will use it. I think we will use it far more efficiently.

Mr. DOYLE. OK. So you would take some government assistance? It sounded like you told Mr. Stearns that you weren't interested in that and you didn't need it.

Mr. DANKBERG. I am just from a free enterprise perspective if I am competing with other carriers who are subsidized, am I supposed to compete on an unsubsidized basis with companies that are given thousands of dollars per home served? I don't know how to respond to that.

Mr. DOYLE. I am not asking you to. I just thought that is what you told Mr. Stearns and I just wanted to get clarification on it that if there is money there you will take it. And maybe just finally since I still have a minute and 30 seconds in the remaining time, you heard what Ms. Gillett said about whether or not this Universal Service Fund reform would result in people losing their telephones or not, does anybody have any further comments on that, and generally I take it you all support reform. You just think it needs to go a little quicker and a little further than it is going right now. Is that accurate? OK. All right. Well, I think I have asked everything I want to, Mr. Chairman. Thanks.

Mr. BOUCHER. Thank you very much, Mr. Doyle. The gentlelady from Tennessee, Ms. Blackburn, is recognized for 5 minutes.

Ms. BLACKBURN. Thank you, Mr. Chairman. I want to thank all of you for your patience with us today. Mr. Turner, I want to be sure that I understood you to say that you did think it was unfortunate that we had put the cart before the horse when it came to not doing the mapping and not doing our definitions. Did I understand that right? Yes or no is sufficient.

Mr. TURNER. Yes.

Ms. BLACKBURN. OK. Thank you for that. And, Mr. Garcia, I appreciate that you appreciate the fact that the fund has been around for a long time but the money doesn't seem to get out very quickly. I think that is the frustration whenever you see government step in to what the private sector has done. And, Mr. Chairman, I want to ask unanimous consent to enter for the record an editorial from the Washington Post that indicates that heavy regulation is unnecessary in light of the broadband plan's analysis that 95 percent of the country has access to broadband, and we have gone from 8 million broadband subscribers to 200 million in the last 10 years.

Mr. BOUCHER. Without objection, that will be made a part of the record.

[The information appears at the conclusion of the hearing.]

Ms. BLACKBURN. Thank you, Mr. Chairman. Dr. Eisenach, my question is to you. Doesn't this suggest that our deregulatory approach is working and that we should focus any government effort just on the 5 percent or the 7 million homes that are in an area that does not receive the private sector access to the broadband services?

Mr. EISENACH. Absolutely.

Ms. BLACKBURN. And I appreciate your answer on that. I also had another question I wanted to ask you. When we look at the issues of Network Neutrality, unbundling, compelled wholesaling, rate regulation, is there any economic validity to the arguments that these issues, Network Neutrality, unbundling, compelled wholesaling, would encourage broadband deployment to the last mile and wouldn't regulating broadband just chill the investment innovation that we have seen over the past 10 years that has led to 200 million homes being connected?

Mr. EISENACH. In 2 respects, and the first respect is a matter of economics. These issues have been very fully studied. Last week, I was one of 21 economists, very broad-based group, former CAB chairman Alfred Kahn among us, filing comments with the Federal Communications Commission specifically on the plan of the Net Neutrality and PRM, and our conclusion, simply put, is that the economic evidence simply does not support those proposed rules and indeed that those proposed rules, if adopted, would reduce innovation, reduce investment, reduce deployment in the way that we are talking about here today. The same set of data, I think, or the same economic facts are there on the issue of unbundling, and, indeed, there is a lot of evidence in the FCC's National Broadband Plan——

Ms. BLACKBURN. If I can ask one additional question. I guess the same would apply to the reclassification?

Mr. EISENACH. Well, absolutely, because the reclassification is simply a precursor and would be seen in the marketplace as a precursor to imposing this sort of heavy-handed regulation. The second issue is the commission has laid down a very ambitious agenda. As I implied earlier, it will be interesting to see how well it does keeping to the schedule that it has laid out. If it were to embark on these major new rulemakings, already in the middle of one of them on Net Neutrality, on reclassification, unbundling, and so forth, I simply question whether or not universal service won't once again as it has for 15 years fall to the back of the pack in terms of priority, and we will end up sitting here a decade from now saying why are we still spending now $8 billion of high cost subsidized telephone service.

Ms. BLACKBURN. Thank you. I appreciate that. Ms. Gillett, I have got just a few minutes left, but I want to go back to something. Mr. Markey said when we have a plan, we win, when we don't, we lose. And we all believe that, but we think we got the cart before the horse on this one. It looks like there are many on the panel that agree with that. And so we do have concerns about how you all will go about as you assess the data that you say is now beginning to come in, and you are saying you think you are going to have sufficient data to address what you term the broadband gap and by early next year. So as you do this, how are you going to look at that and address this gap but make certain that existing consumers are not going to see their rates go up, that they are not going to see additional taxes, additional fees, that they are not going to see their rates go up because one of the concerns we hear is that they are concerned that if you all get involved in this, then consumers who like the plan they have got right now, they are going to see their rates elevated. So what is your plan to address that?

Ms. GILLETT. A couple of things. First of all, the premise of the plan is that the universal service stays at the size it is so the burden would not go up on consumers. And, secondly, about the data point, between the BDIA map and the better data that the FCC is proposing to collect by the time, as Mr. Turner says, by the time we are able to implement these—I just received word that the first proceeding on the universal service reform was just adopted by the commission this morning, so we are on our way doing that, but by the time we get new rules in place and new money flowing the new data will be in and available for use.

Ms. BLACKBURN. OK. I am out of time. Yield back.

Mr. BOUCHER. Thank you, Ms. Blackburn. The gentleman from Illinois, Mr. Rush, is recognized for 5 minutes.

Mr. RUSH. Thank you, Mr. Chairman. My question is for Mr. Villano. Mr. Villano, last year Senator Menendez and I sent a letter to your agency and also to the NTIA expressing concerns about the number and the amount of stimulus grants that have been awarded to small and minority applicants in your initial round of decision. I would like to know what you have done to improve those numbers. What percentage of total awards to date have been made to these types of applicants, and are there any additional improvements on the table in terms of increasing the number of approved applicants?

Mr. VILLANO. Thank you for the question. We did take those concerns very seriously when we developed our second NOFA. I think if you read the second NOFA, you will see that we tripled the number of points that we afford to socially disadvantaged businesses and their applications. We also award non-socially disadvantaged businesses extra points if they provide lower cost service to socially disadvantaged businesses in the service areas. Do we publish the NOFAs? We did 10 workshops. We had planned to do 10 workshops. One of them was shut down because of the snowstorms we had here in Washington. But we did 9 outreach and training sessions throughout the country, and at all those sessions we had special outreach sessions for minority and native applicants for the program. In NOFA 2, about 8 percent of the applications that we received under the BIP program are from socially disadvantaged businesses.

Mr. RUSH. Can you quantify the number of grants?

Mr. VILLANO. Under our second NOFA which just closed on——

Mr. RUSH. The first one and the second one.

Mr. VILLANO. Under our first NOFA, we made 68 awards and one of those awards was to a socially disadvantaged business that was Revada Sea Lion up in Alaska. Under NOFA 2, we have 61 applications from socially disadvantaged businesses.

Mr. RUSH. Those have been approved. All right. And are you satisfied with the level of applicants and the process and the level of outcome in terms of your productivity?

Mr. VILLANO. We are pleased with the results under NOFA 2. We have a total of 776 applications for $11 billion in funding. We have a little over $2 billion available this round, and we are in the process of reviewing those applications and hope to have awards out this summer.

Mr. RUSH. Thank you, Mr. Chairman. Yield back.

Mr. BOUCHER. Thank you very much, Mr. Rush. The gentleman from Washington State, Mr. Inslee, is recognized for 5 minutes.

Mr. INSLEE. Thank you. Ms. Gillett, could you respond to Mr. Garcia's suggestions about improving the relationship, the government relationship, to tribes in this context and how that might work and how we can make it work?

Ms. GILLETT. Certainly. The plan, as you know, makes many recommendations, including a number that Mr. Garcia spoke about, including, for example, the Office of Tribal Affairs at the FCC, a seat on the USAC board, and so forth, and we look forward to implementing those and would be happy to—our Consumer and Governmental Affairs Bureau will be implementing those recommendations, and I would be happy to have them get back to you with further information about how that is proceeding. And we also recently made public our implementation schedule, which has the dates and quarters of addressing a number of those recommendations on it.

Mr. INSLEE. Well, that is encouraging, and if we can help you at all, let us know. We appreciate that.

Ms. GILLETT. Thank you.

Mr. INSLEE. We think that is very important. Mr. Turner, I wanted to ask you about FCC authority in light of this case that came down. The FCC has identified several areas that could be impacted of this that people may not think of including cyber security efforts, universal service reform, access for disabled Americans, and consumer privacy. There is a whole list of things that could be affected. If the FCC does nothing in response to this decision, what will happen to the FCC's ability to advance those policy goals?

Mr. TURNER. It is casting serious doubt. I think if you look at the statute and look at how the statute was developed, Congress at the time clearly treated and wanted to treat the wires that bring us these services differently from the services themselves, and this was the heart of 230B, hands-off approach to the internet services, but a light regulatory touch where needed on the wires. And I have a lot of trust in the deliberative wisdom of Congress on the shelf life of these laws because they are based on principles like universal service, nondiscrimination interconnection, competition, and reasoned deregulation. The path Congress gave the FCC for the regulation was Section 10. Chairman Powell chose to do a different path through the re-definition process, and I think, you know, in the words of Justice Scalia, this was sort of a Mobius Strip type of reasoning that ignored the statute.

I think Chairman Powell thought he could stand up all the other principles of interconnection, universal service, non-discrimination, disability access, all of that on this ancillary authority theory, and the court case has shown that that is not going to be able to be the case, so the move towards reclassification doesn't have to be seen as a radical move. It simply will be a move that puts the FCC's regulatory framework back in harmony with the law, and I guarantee you it will come with some type of heavy forbearance on all the rules that are intended to apply to monopoly telephone networks. They certainly will not be applied to broadband networks.

And we must remember that today the enterprise broadband market that serves the biggest businesses in the country is currently regulated under Title 2 and that is one of the most competitive markets and they are not screaming for deregulation and there is heavy investment going on there.

Mr. EISENACH. If I could just jump in very quickly and say at least with respect to the Net Neutrality regulations that are proposed the non-discrimination provisions are not less restrictive on broadband than what was put in place on telephone networks in the past. They are more restrictive. The non-discrimination provisions that were in place on telephone networks in the past permitted just as reasonable discrimination. The proposed Net Neutrality regulations explicitly reject that approach and say there will be no discrimination of any kind. To suggest that the private sector could have any confidence that the regulations that would be imposed under a Title 2 classification are less restrictive than what had been imposed in the past is just violated by the proposed rules we have in front of us today.

Mr. INSLEE. Well, I just point out that I think it is even a dicier gamble to have any confidence that if we don't do something about Net Neutrality there won't be marketplace efforts to restrict access to content, and I think it is clear we need action on here. And I appreciate Mr. Turner's views in this regard. Thank you.

Mr. BOUCHER. Thank you, Mr. Inslee. The gentleman from Ohio, Mr. Space, is recognized for 5 minutes.

Mr. SPACE. Thank you, Mr. Chairman. This map is a map of the State of Ohio, and, as you can see, in the southwestern corner, which is the green area which would indicate the unserved area pursuant to the work done by Connect Ohio, which is modeled on Connect Kentucky, and I have a lot of faith in the work that they have done in trying to decide or determine just where access to broadband exists and where it doesn't exist. And the effect that that is having on the people of southeastern Ohio is significant. If you look at the unemployment rates in these counties, 5 of them are above 15 percent, 1 above 18 percent right now. That represents the unemployment rate doesn't even factor in the tens of thousands of people that are fully employed but are working in poverty.

This is a significant problem that hampers economic development. It limits our already limited access to health care, education. We see the role of broadband and its integration in health care delivery, educational delivery systems as in its infancy right now going nowhere but up, and it longer it takes for us to obtain this access the farther behind we are going to fall. That also happens to correspond almost identically with my congressional district. And we are working hard to see what we can do to provide access to this very important technology. And one of the questions I have for the panel, and I am going to ask a number of you specifically to just give, if you can, because our time is limited, a 2 or 3-sentence response to this question. Ms. Gillett, I am going to ask you first. What is it that we can do, Congress can do, to facilitate extension of that last mile to maybe it is 5 percent of the population, maybe 7 percent, I don't know, but I know that percentage is a lot bigger in areas like this, what can we do as a Congress to facilitate the extension of that last mile to those people who don't have any access right now?

Ms. GILLETT. I would suggest 3 things. First, would be to work with us on the universal service reform so that we can target the funds to the places that are unserved. It is a complicated system, as Mr. Eisenach mentioned. Reform has been tried many times. There is lots of people in the current system so it is complicated, and we would appreciate your support with that. Second is we propose to do it in the plan with no additional funds but the plan does also pose an option for Congress to consider an appropriation which could help make it go faster. And the third thing is I think your point about you got the data, you know where these places are. That is great. The cooperation of industry in making sure we have accurate availability data is key.

Mr. SPACE. Thank you. Mr. Villano.

Mr. VILLANO. Certainly. I would suggest that anybody that you have that is looking for service in those areas would contact their field representative to determine if they could apply for one of our programs. Under the broadband initiative program we made 4 awards in the State of Ohio under NOFA 1. Under NOFA 2, we have 21 pending applications for $193 million. I hope that some of those are in your district.

Mr. SPACE. They are.

Mr. VILLANO. And that they will filter their way up to the top. But it would be most important for applicants to contact RUS and the Rural Development state office to see which programs that we have that may be of assistance to those communities.

Mr. SPACE. Thank you. Mr. Eisenach, I want to ask you for maybe your perspective on how we bridge that last mile in places like this.

Mr. EISENACH. First of all, I think doing something is important. I don't think it is going to entirely solve itself. I do think that satellite service is my earlier answer to the question where will we be in 10 years. I do think that satellite for a lot of purposes is going to solve a lot of people's problems. I don't think it is going to solve the high capacity issue in terms of what you want in a hospital or what you want in a government office and areas like that. What works? What I have seen work is what is working in Virginia, a state where I have spent a lot of time looking closely and I know is working in other places around the country, and that is looking at local solutions. So what we have in the State of Virginia, something called the Mid-Atlantic Broadband Council, I have been involved with that, the Southwestern Virginia Technology Council. The chairman has been intensely involved with that.

And what those local groups are able to go is pull together businesses, government, public non-governmental organizations, and solve problems. These are not problems of rocket science. These are problems of digging a ditch and putting some fiber in or putting up a tower, and often those problems just take the business community getting together with funding, with funding, but often it is a question of people getting together and saying we need to put a tower up here. Let us get it done.

Mr. SPACE. Sure. And the problem, however, is in areas like this the local community governments and many of the businesses are struggling to survive, and they don't have the means.

Mr. EISENACH. I am for funding those efforts. Just to be clear, those efforts in Virginia have been funded by a tobacco fund, and I think the RUS has been active in funding those efforts. Those are good efforts. Those efforts ought to be funded in my view.

Mr. SPACE. I know I am over time, but the chairman is busy and not paying attention to my time. Mr. Chairman, may I have just 1 more minute?

Mr. BOUCHER. Yes, sir. Go ahead, Mr. Space.

Mr. SPACE. Mr. Dankberg, the issue has to do with satellite availability in areas like this, and the problem as I see that is the capacity in the cost and the quality don't—you testified that you feel they are comparable, but as we move forward it is all about speed and it is all about quality and capacity, and I question whether or not the technology is there for satellite.

Mr. DANKBERG. I understand that. I am an engineer. We just designed a new satellite that has 20 times the capacity of the best satellite ever. I think it is a question of economics. And what we would say just set us a target. If you set a target of 5 megabits, 10 megabits, we will figure out what the economics are. We can deliver 5, 10, 15, 20. Set a number that you would like and then have a competition, and if we can't meet that number we are happy to see it go somewhere else.

Mr. SPACE. Thank you, Mr. Dankberg. My time has expired.

Mr. BOUCHER. Mr. Space, if you would yield to me just a second the balance of your time which will be extended as much as is necessary. I wonder, Mr. Dankberg, if you would make a project of what the retail cost per customer is going to be for that new high capacity satellite that you intend to launch.

Mr. DANKBERG. I think one of the main points that was made was the price of broadband coming down. Our new satellite, we will offer—we probably are going to offer plans just like we do now, which are $50, $60 or $80. We will increase the speeds that we offer by a factor of 4, and the amount of congestion, which is really the reason that people perceive delay, will go enormously.

Mr. BOUCHER. So if you can afford $50, $60 or $80, that is fine. If you are among that category of individuals who can't, it becomes a problem.

Mr. DANKBERG. What we would say is we are completely fine with the idea of using subsidies to reduce prices for people who can't afford it. We are absolutely OK with that. That can absolutely apply to satellite, and we proposed to the RUS a satellite system that would make life line broadband service available at $8 per month wholesale at 768 kilobits a second. All we want to do is have an opportunity to compete at whatever speed, and if subsidies are used, we just want to compete to provide service to all of Ohio for the same price that might serve one small village at whatever level of service is specified.

Mr. BOUCHER. OK. Thank you very much, Mr. Dankberg. Mr. Stearns, I will just recognize you. Mr. Space's time has expired.

Mr. STEARNS. Thank you, Mr. Chairman. I just want to ask, what speed would that be? You say 4 times. What would that speed be?

Mr. DANKBERG. The speeds for our new satellite, we expect to offer 2, 4, and 8 megabits per second as the speeds for our service at those retail prices. Our wholesale prices are about half of that. The retailers are the ones that mark it up by about a factor of 2.

Mr. BOUCHER. Thank you. Mr. Dankberg. Let me say thank you to each of our witnesses today. We appreciate very much your taking this time and sharing your insights with us. I am going to leave the record of this hearing open for approximately 3 weeks during which period of time there probably will be some written questions propounded to you by the members of the subcommittee. When you receive those questions, I hope you will respond promptly, and we will make your responses part of the record of this hearing. And the gentleman from Florida is recognized.

Mr. STEARNS. Just to ask unanimous consent for all members' statements to be included in the record.

Mr. BOUCHER. Without objection. With that, this hearing is adjourned with the thanks of the subcommittee.

[Whereupon, at 12:38 p.m., the Subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

THE BROADBAND AVAILABILITY GAP

OBI TECHNICAL PAPER NO. 1

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LIST OF EXHIBITS

LIST OF ASSUMPTIONS

This table provides important information about the different assumptions used in the creation of charts throughout this document. The assumptions implicit in each chart are appropriate for the context in which the chart appears. However, it may be the case that assumptions vary between similar charts, leading to what appear to be different results. This table synthesizes the different assumptions to allow the reader to interpret and compare charts in this document.

			Key assumptions	
Chart	Description	Technology	4G Areas	Non-4G areas
1-A	Base-case Broadband Availability Gap Profitable counties are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
1-B	Breakout of Ongoing Costs by Category Profitable counties are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
1-C	Gap by Census Blocks Ordered by Population density The second lowest cost technology is determined at the county level and assigned to the census blocks. All unserved census blocks then are sorted into centiles by their gap.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
1-D	Broadband Investment Gap per County	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
1-E	Broadband Investment Gap per Housing Unit in Each County	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
1-G	Broadband Investment Gap, by County Profitable counties are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
1-H	Ongoing Support for Each Housing Unit per Month	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
1-I	Investment Gap per Housing Unit by Lowest-Cost Technology for Each County	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.

			Key assumptions	
Chart	Description	Technology	4G Areas	Non-4G areas
1-J	Lowest Cost Technology All unserved areas are included.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
3-A	Impact of Discount Rate on Investment Gap Profitable counties are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
3-D	Gap for Funding One Wired and One Wireless Network Profitable counties for each technology are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
3-E	The Cost of Funding Two Wired Networks Profitable counties for each technology are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes one competitor.
		FTTP	Assumes one competitor.	Assumes one competitor.
3-G	Quantifying the Impact of Competition: Investment Gap by Number of Providers Profitable counties are excluded.	12,000-foot DSL	Assumes 0-3 competitors as indicated by label.	Assumes 0-3 competitors as indicated by label.
		Fixed Wireless	Assumes 0-3 competitors as indicated by label. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes 0-3 competitors as indicated by label. Recognizes only Fixed revenue as incremental.
3-H	Broadband Investment Gap by Percent of Unserved Housing Units The second-lowest-cost technology is determined at the county level and assigned to the census blocks. All unserved census blocks then are sorted into centiles by their gap.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
3-I	Total Investment Cost for Various Upgrade Paths	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network.	Assumes no competitors.
		5,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		3,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		FTTP	Assumes one competitor.	Assumes no competitors.
3-M	Dependence of the Broadband Investment Gap on Speed of Broadband Considered Profitable counties are excluded.	15,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
		5,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		3,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		FTTP	Assumes one competitor.	Assumes no competitors.
		HFC	Assumes one competitor.	Assumes no competitors.

			Key assumptions	
Chart	Description	Technology	4G Areas	Non-4G areas
3-U	Sensitivity of Gap to Take Rate Profitable counties are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
3-W	ARPU Sensitivity Profitable counties are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
3-Z	Sensitivity of Build-Out Cost and Investment Gap to Terrain Classification Parameters Profitable counties are excluded.	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
4-C	Present Value of Total Costs for All Technologies in Unserved Areas The second lowest cost technology is determined at the county level and assigned to the census blocks. All unserved census blocks then are sorted into centiles by their gap.	12,000-foot DSL	Assumes no competitors.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network.	Assumes no competitors.
		5,000-foot DSL	Assumes no competitors.	Assumes no competitors.
		3,000-foot DSL	Assumes no competitors.	Assumes no competitors.
		FTTP	Assumes no competitors.	Assumes no competitors.
		Cable	Assumes no competitors.	Assumes no competitors.
4-W	Investment Gap for Wireless networks Profitable counties are excluded.	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
4-Y	Sensitivity of Investment Gap to Terrain Classification Profitable counties are excluded.	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
4-Z	Sensitivity of Costs and Investment Gap to Subscriber Capacity Assumptions Profitable counties are excluded.	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
4-AA	Impact of Spectrum Availability on FWA Economics Considers all unserved areas for first column of data; profitable counties are excluded in the other columns.	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
4-AB	Cost Breakdown of Wireless Network Over 20 Years Considers all unserved areas (including profitable counties).	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network.	Assumes no competitors.
4-AC	Cost of Deploying a Wireless Network in Unserved Areas Considers all unserved areas (including profitable counties).	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network.	Assumes no competitors.

Chart	Description	Technology	Key assumptions: 4G Areas	Key assumptions: Non-4G areas
4-AD	Cost of an HFM Second Mile Backhaul Architecture	Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network.	Assumes no competitors.
4-AK	Economic Breakdown of 12,000-foot DSL Profitable counties are excluded.	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
4-AP	Economics of Terrestrially Served if Most Expensive Housing Units are Served with Satellite Includes all unserved areas (including profitable counties).	12,000-foot DSL	Assumes one competitor.	Assumes no competitors.
		Fixed Wireless	Assumes no competitors. Applies a 73.13% cost allocation to the fixed network. Recognizes only Fixed revenue as incremental.	Assumes no competitors. Recognizes Fixed and Mobile revenue as incremental.
4-AV	Breakout of FTTP Gap Profitable counties are excluded.	FTTP	Assumes no competitors.	Assumes no competitors.
4-BE	Breakout of 3,000-Foot DSL Gap Profitable counties are excluded.	3,000-foot DSL	Assumes no competitors.	Assumes no competitors.
4-BF	Breakout of 5,000-Foot DSL Gap Profitable counties are excluded.	5,000-foot DSL	Assumes no competitors.	Assumes no competitors.
4-BG	Breakout of 15,000-Foot DSL Gap Profitable counties are excluded.	15,000-foot DSL	Assumes one competitor.	Assumes no competitors.

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INTRODUCTION

The American Recovery and Reinvestment Act directed the Federal Communications Commission (FCC) to include, as part of the National Broadband Plan (NBP), "an analysis of the most effective and efficient mechanisms for ensuring broadband access by all people of the United States."[1] As the NBP indicated, the level of additional funding to extend broadband to those who do not have access today is $23.5 billion; more detail about the gap and results of this analysis are presented in Chapter 2. This document details the underlying analyses, assumptions and calculations that support the $23.5 billion funding gap.[2]

The question implicit in the Congressional mandate is deceptively simple: What is the minimum level of public support necessary to ensure that all Americans have access to broadband? In fact, there are multiple layers of complexity: The analysis must account for existing deployments, both to the extent that they enable current service and can be used to extend service to currently unserved areas; and it must include an analysis of the capabilities and economics of different, competing technologies that can provide service. The analysis therefore comprises two main components: The first focuses on *Availability*, or understanding the state of existing network deployments and services; the second focuses on the *Funding Shortfall*, the capabilities and economics associated with different broadband networks.[3] See Exhibit A.

The *Availability* analysis focuses on determining the state of existing deployments: who has access, and of greater concern, who lacks access to broadband consistent with the National Broadband Availability Target. In addition, this analysis must develop a key input to the Funding Shortfall analysis: data regarding the location of existing network infrastructure to facilitate determining the cost of extending service into unserved areas. Developing this detailed baseline requires a very granular geographic view of the capabilities of all the major types of broadband infrastructure as they are deployed today, and as they will likely evolve over the next three to five years without public support.

Unfortunately, there is a lack of data at the required level of granularity, both in terms of availability—which people have access to what services—and of infrastructure—which people are passed by what types of network hardware. To solve the problem, we combine several data sets for availability and infrastructure, supplementing nationwide data with the output of a large multivariate regression model. We use this regression model to predict availability by speed tier and to fill in gaps, especially last-mile gaps, in our infrastructure data. The approach to developing this baseline is described in Chapter 2.

The second major component focuses on the *Funding Shortfall* by examining the capabilities and economics of different network technologies. To facilitate this analysis, we built a robust economic model that calculates the amount of support necessary to upgrade or extend existing infrastructure to the unserved to provide service consistent with the target. The economic analysis builds on the infrastructure data—known and inferred—from the first step, calculating the cost to augment existing infrastructure to provide broadband service consistent with the target for multiple technologies.

This calculation ultimately provides the gap between likely commercial deployments and the funding needed to extend universal broadband access to the unserved. Underlying the model's construction are a number of principles that guided its design.

- **Only profitable business cases will induce incremental network investments.** Private capital will only be available to fund investments in broadband networks where it is possible to earn returns in excess of the cost of capital. In short, only profitable networks will attract the investment required. Cost, while a significant

BOX A

The Broadband Availability Gap Model

Models are one tool to analyze complex problems such as the Broadband Availability Gap. It is important to recognize, however, that models have limits. An engineering-based, multi-technology economic model of broadband deployment, like the one created as part of the National Broadband Plan (NBP) effort, requires a multitude of inputs and can be used to answer many different questions. The types of inputs range from simple point estimates, such as the cost of a piece of hardware—a Digital Subscriber Line Access Multiplexer (DSLAM) card or chassis, for example— estimates of per-product revenue, assumptions about the evolution of competitive dynamics in different market segments and the likely behavior of service providers. We form hypotheses about all of these types of inputs to calculate the Broadband Availability Gap; of necessity, some of these hypotheses are more speculative than others.

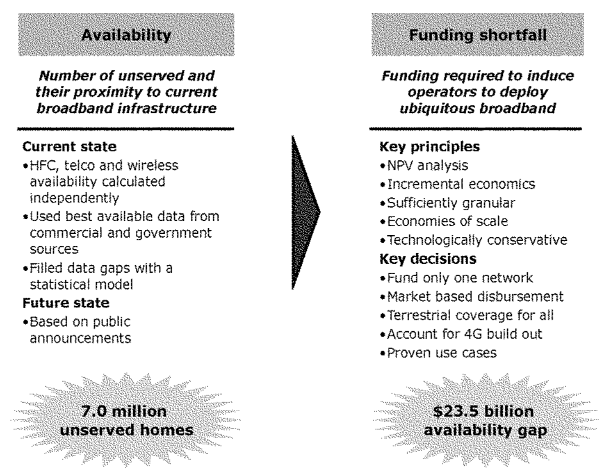
This paper describes the design and use of this model in providing input into the NBP, as well as the underlying views about the relevant technologies. Others may make different assumptions or test different hypotheses or seek to answer somewhat different questions. The model and its associated documentation provide an unprecedented level of transparency and should spur debate. The intent is for this debate to ultimately improve our understanding of the economics related to offering broadband service so that public policy can be made in a data-driven manner.

driver of profitability, is not sufficient to measure the attractiveness of a given build; rather, the best measure of profitability is the net present value (NPV) of a build. This gap to profitability in unserved areas is called the Broadband Availability Gap in the NBP; throughout this paper, we will refer to this financial measure as the Investment Gap.

- **Investment decisions are made on the incremental value they generate.** While firms seek to maximize their overall profitability, investment decisions are evaluated based on the incremental value they provide. In some instances, existing assets reduce the costs of deployment in a given area. The profitability of any build needs to reflect these potential savings, while including only incremental revenue associated with the new network build-out.
- **Capturing the local (dis-)economies of scale that drive local profitability requires granular calculations of costs and revenues.** Multiple effects, dependent on local conditions, drive up the cost of providing service in areas that currently lack broadband: Lower (linear) densities and longer distances drive up the cost of construction, while providing fewer customers over whom to amortize costs. At the same time, lower-port-count electronics have higher costs per port. In addition, these lower densities also mean there is less revenue available per mile of outside plant or per covered area.
- **Network-deployment decisions reflect service-area economies of scale.** Telecom networks are designed to provide service over significant distances, often larger than five miles. In addition, carriers need to have sufficient scale, in network operations and support, to provide service efficiently in that local area or market. Given the importance of reach and the value of efficient operations, it can be difficult to evaluate the profitability of an area that is smaller than a local service area.
- **Technologies must be commercially deployable to be considered part of the solution set.** Though the economic model is forward-looking and technologies continue to evolve, the model only includes technologies that have been shown to be capable of providing carrier-class broadband. While some wireless 4G technologies arguably have not yet met this threshold, successful market tests and public commitments from carriers to their deployment provide some assurance that they will be capable of providing service.

Implicit within the $23.5 billion gap are a number of key decisions about how to use the model. These decisions reflect

Exhibit A: Approach to Determining the Availability Gap[4]



beliefs about the role of government support and the evolution of service in markets that currently lack broadband. In short, these decisions, along with the assumptions that follow, describe how we used the model to create the $23.5 billion base case.

- **Fund only one network in each currently unserved geographic area.** The focus of this analysis is on areas where not even one network can operate profitably. In order to limit the amount of public funds being provided to private network operators, the base case includes the gap for funding only one network.
- **Capture likely effects of disbursement mechanisms on support levels.** Decisions about how to disburse broadband-support funds will affect the size of the gap. Market-based mechanisms, which may help limit the level of government support in competitive markets, may not lead to the lowest possible Investment Gap in areas currently unserved by broadband—areas where it is difficult for even one service provider to operate profitably.
- **Focus on terrestrial solutions, but not to the exclusion of satellite-based service.** Satellite-based service has some clear advantages relative to terrestrial service for the most remote, highest-gap homes: near-ubiquity in service footprint and a cost structure not influenced by low densities. However, satellite service has limited capacity that may be inadequate to serve all consumers in areas where it is the lowest-cost technology. Uncertainty about the number of unserved who can receive satellite-based broadband, and about the impact of the disbursement mechanisms both on where satellite ultimately provides service and the size of the Investment Gap, all lead us to not explicitly include satellite in the base-case calculation.
- **Support any technology that meets the network requirements.** Broadband technologies are evolving rapidly, and where service providers are able to operate networks profitably, the market determines which technologies "win." Given that, there appears to be little-to-no benefit to pick technology winners and losers in areas that currently lack broadband. Therefore, the base case includes any technology capable of providing service that meets the National Broadband Availability Target to a significant fraction of the unserved.
- **Provide support for networks that deliver proven use cases, not for future-proof build-outs.** While end-users are likely to demand more speed over time, the evolution of that demand is uncertain. Given current trends, building a future-proof network immediately is likely more expensive than paying for future upgrades.

Also implicit in the $23.5 billion gap are a number of major assumptions. In some sense, every input for the costs of network hardware or for the lifetime of each piece of electronics is an assumption that can drive the size of the Investment Gap. The focus here is on those selected assumptions that may have a disproportionately large impact on the gap or may be particularly controversial. By their nature, assumptions are subject to disagreement; Chapter 3 includes an estimate of the impact on the gap for different assumptions in each case.

- Broadband service requires 4 Mbps downstream and 1 Mbps upstream access-network service.
- The take rate for broadband in unserved areas will be comparable to the take rate in served areas with similar demographics.
- The average revenue per product or bundle will evolve slowly over time.
- In wireless networks, propagation loss due to terrain is a major driver of cost that can be estimated by choosing appropriate cell sizes for different types of terrain and different frequency bands.
- The cost of providing fixed wireless broadband service is directly proportional to the fraction of traffic on the wireless network from fixed service.
- Disbursements will be taxed as regular income just as current USF disbursements are taxed.
- Large service providers' current operating expenses provide a proxy for the operating expenses associated with providing broadband service in currently unserved areas.

These principles, decisions and assumptions are discussed in detail in Chapter 3.

In addition to the key assumptions above, there are numerous other assumptions that we made for each broadband technology we examined. In order to accurately model each technology, we had to understand both the technical capabilities and the economic drivers; a description of our treatment of each technology is provided in Chapter 4.

In addition to this technical paper, there is supplementary documentation describing our analysis and methods including CostQuest Model Documentation: Technical documentation of how the model is constructed, including more detail about the statistical model used to estimate availability and network infrastructure in areas where no data are available.

ENDNOTES

1. American Recovery and Reinvestment Act of 2009, Pub.L. No. 111-5, § 6001(k)(2)(D). 123 Stat. 115, 516 (2009) (Recovery Act).
2. Note the figure differs slightly from Exhibit 8-B of the first printing of the National Broadband Plan (NBP). While the gap remains $24 billion, the data in this paper are updated since the release of the NBP; future releases of the NBP will include these updated data.
3. As a threshold matter, the level of service to be supported must be set. This service is the National Broadband Availability Target which specifies downstream speeds of at least 4 Mbps and upstream speeds of at least 1 Mbps. Support for this target is discussed briefly in Section 4 and in detail in the Omnibus Broadband Initiative's (OBI) technical paper entitled Broadband Performance (forthcoming).
4. Homes are technically housing units. Housing units are distinct from households. "A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters." In contrast, "A household includes all the persons who occupy a housing unit. . . . The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements." There are 130.1 million housing units and 118.0 million households in the United States. U.S. Census Bureau, Households, Persons Per Household, and Households with Individuals Under 18 Years, 2000, http://quickfacts.census.gov/qfd/meta/long_71061.htm (last visited Mar. 7, 2010).

1. THE INVESTMENT GAP

Our analysis indicates that there are 7 million housing units (HUs) without access to terrestrial broadband infrastructure capable of meeting the National Broadband Availability Target of 4 Mbps download and 1 Mbps upload. Because the total costs of providing broadband service to those 7 million HUs exceed the revenues expected from providing service, it is unlikely that private capital will fund infrastructure capable of delivering broadband that meets the target.

We calculate the amount of support required to provide 100% coverage to the unserved consistent with the availability target to be $23.5 billion. As shown in Exhibit 1-A, the $23.5 billion gap is the net shortfall, including initial capital expenditures (capex), ongoing costs and revenue associated with providing service across the life of the asset.

Ongoing costs comprise ongoing capex, network operating expenses and selling, general and administrative expenses; the present values of these costs are shown in Exhibit 1-B.

Costs and the gap vary dramatically with population density, with the least densely populated areas accounting for a disproportionate share of the gap (see Exhibit 1-C). As noted in the NBP, and discussed more fully in the *Satellite* portion of Chapter 4, the highest-gap 250,000 housing units account for $13.4 billion of the total $23.5 billion investment gap.

In fact, deployment costs and the gap are driven largely by the density of the unserved, as will be discussed here and in Chapter 2 (see, for example, Exhibits 1-F and 2-D). Therefore, satellite-based broadband, which can provide service to almost any subscriber regardless of location and at roughly the same cost, could be an attractive part of the overall solution.

We rely on these results to represent an aggregate, nationwide figure. We are more cautious with results in specific geographies because the estimates of the availability of broadband capable networks are in part based on a statistical model (see Chapter 2 for more detail). When examined at a very granular level, the availability model will sometimes overestimate and sometimes underestimate service levels, but should tend to balance out when aggregated to larger geographic areas. In the maps throughout this section we aggregate outputs to the county, but data should still be considered only directionally accurate. Further analysis and improved source data would be required to refine estimates for particular geographies.

The map in Exhibit 1-D presents the Investment Gap for each county in the country. The gap in each county is calculated by adding the gap of all census blocks in that county. Since most counties have at least some census blocks with a net present value (NPV) gap, most counties have an NPV gap. Census blocks with a positive NPV (i.e., blocks where the gap is negative) offset losses in census blocks that are NPV negative. Thus, counties can have no gap if they are currently fully served (i.e., have no unserved), or if the total NPV in the county is positive. Note that dark blue counties have a gap at least 20 times higher than the gap in the light green counties.

Exhibit 1-A: Base-case Broadband Availability Gap—Cash Flows Associated With Investment Gap to Universal Broadband Availability[1]

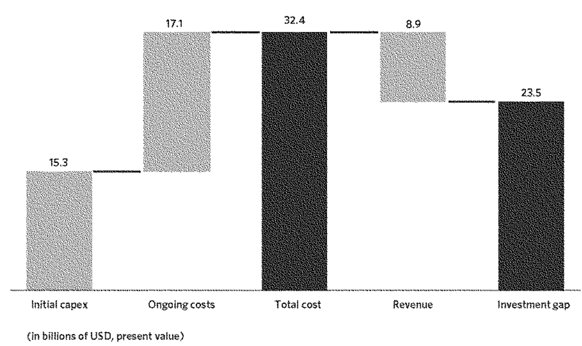
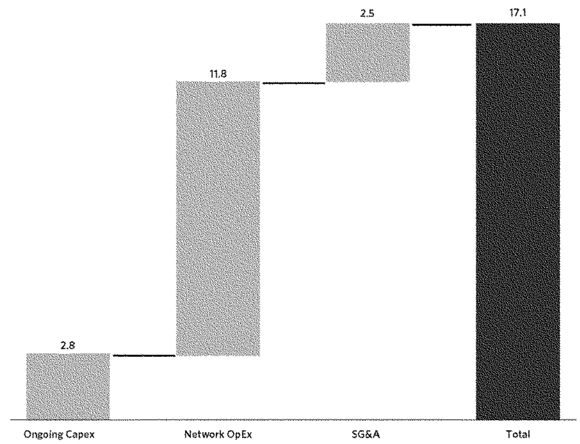
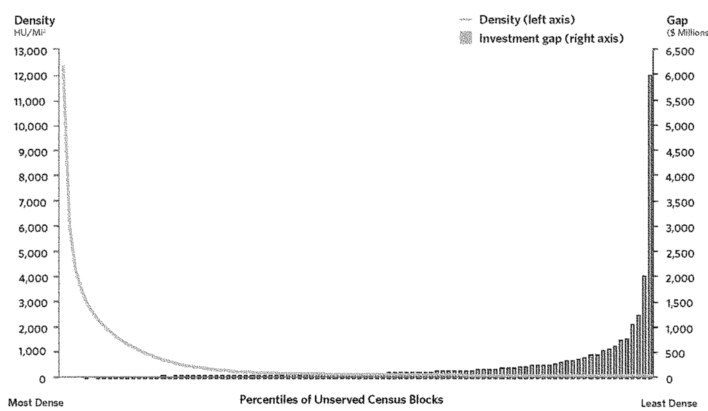


Exhibit 1-B: Breakout of Ongoing Costs by Category



(in billions of USD, present value)
Numbers do not sum due to rounding.

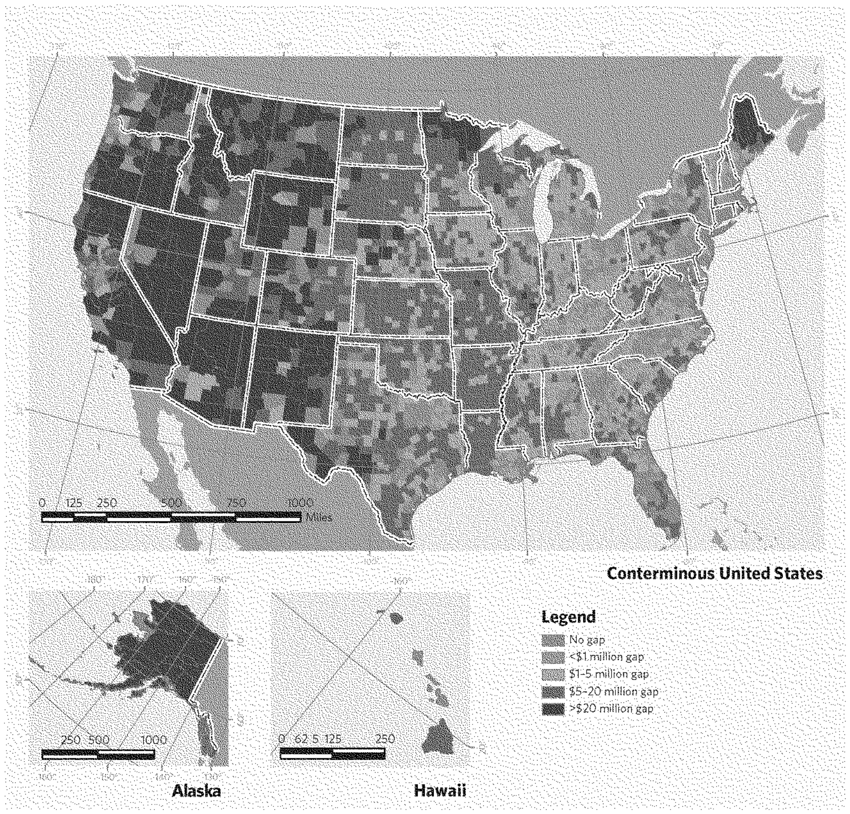
Exhibit 1-C: Gap by Census Blocks Ordered by Population density



(in millions of USD, present value)

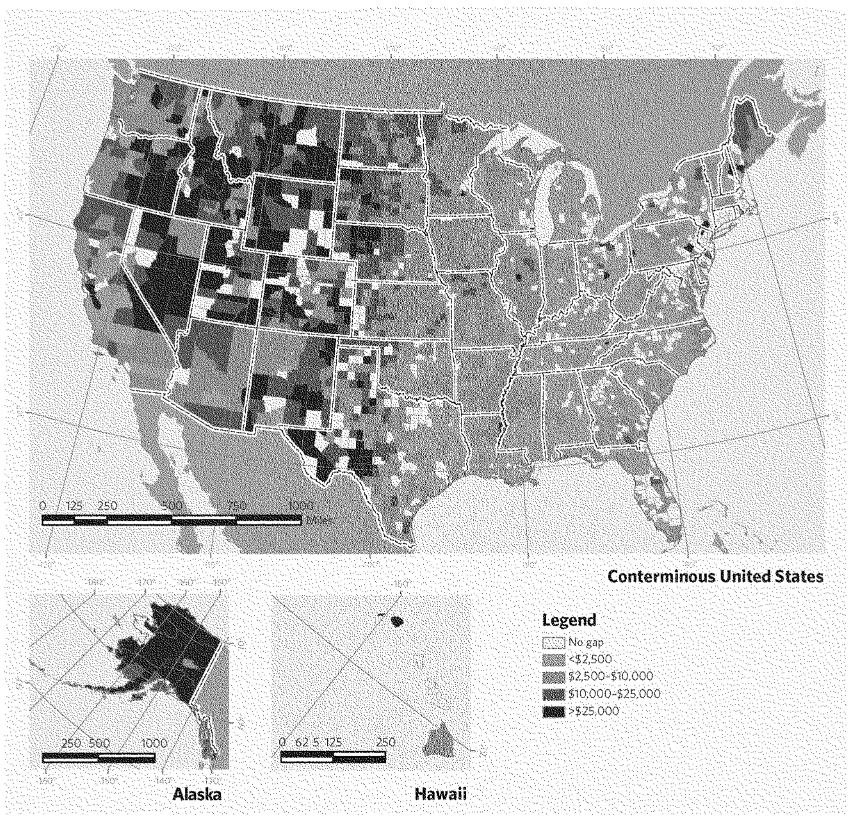
However, the total gap per county tells only part of the story. High county-level gaps can be driven by large numbers of relatively low-gap housing units and/or by small numbers of very high-gap housing units. Examining the gap per housing unit, as shown in Exhibit 1-E, highlights counties where the average gap per home is particularly high. This calculation simply takes the total gap in each county as described above, and divides by the number of unserved housing units in that county. The dark blue counties have a gap per home at least 10 times higher than the gap per home in the green counties.

Exhibit 1-D:
Broadband Investment Gap per County



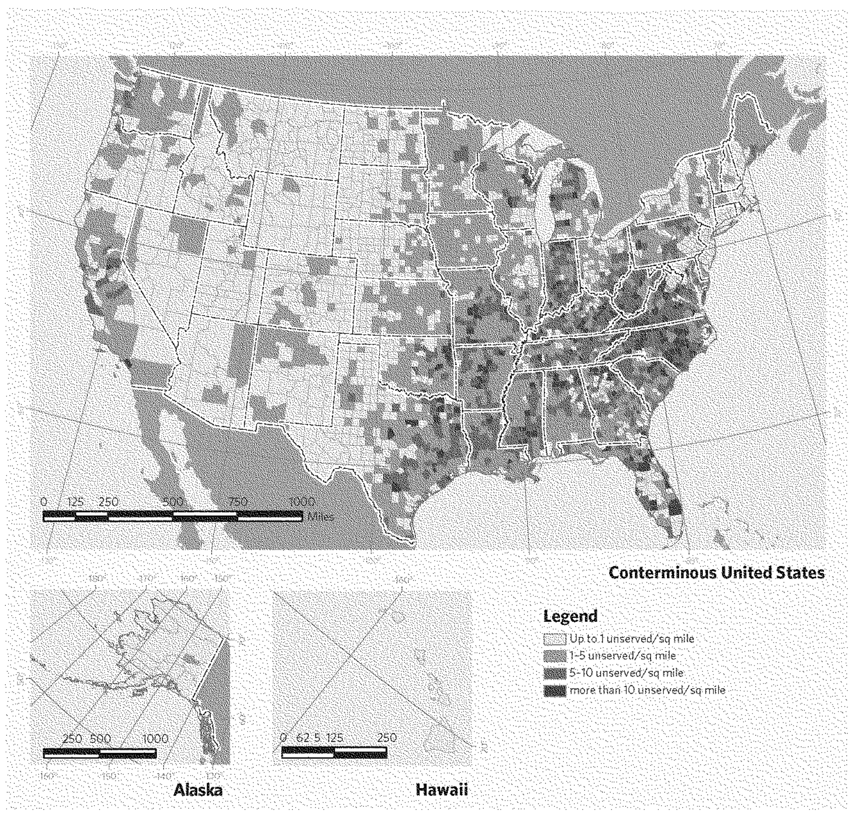
As one might expect, one of the major drivers of cost, and consequently the gap, is the density of unserved housing units (i.e., the number of unserved housing units per square mile, averaged across each county). Areas with higher density as shown in Exhibit 1-F generally have lower gaps per housing unit; note the correlation between low densities in Exhibit 1-F with higher gap per housing unit in Exhibit 1-E. Although density is not the only driver of gap, it is a significant one.

Exhibit 1-E:
Broadband Investment Gap per Housing Unit in Each County



In some areas, the gap exceeds the initial capex required to build out the area. These areas have ongoing costs that are in excess of their revenue—meaning even a network with construction fully subsidized by public funds will not be able to operate profitably. Exhibit 1-G shows the gap for each county, highlighting those where the gap is larger than the initial capex (i.e., markets that require ongoing support), colored in light blue. Areas that require ongoing support generally have larger gaps.

Exhibit 1-F:
Density of Unserved Housing Units per Square Mile



The map in Exhibit 1-H shows the distribution of counties requiring ongoing support across the country. Ongoing support is the monthly annuity required per unserved housing unit to offset ongoing losses (i.e., the amount by which ongoing costs exceed revenues, assuming the network build out is fully subsidized). The darkest colors indicate areas where the highest levels of ongoing support are needed; counties shaded in pink will not need ongoing support.

In Exhibit 1-I, areas in blue are more economic to serve with wireless, and areas in red are cheaper to serve with DSL. For each, darker colors indicate counties with a higher gap per unserved housing unit. This technology comparison is made at the county level, not at a more granular level (See Chapter 3).

Wireline tends to be cheaper in low-density areas (compare Exhibit 1-I with Exhibit 1-F), particularly where terrain drives the need for smaller cell sites that drive up the cost of wireless (see Chapter 4 on wireless technology).

To establish the $23.5 billion gap, it is necessary to make a determination as to which last mile technology is likely to be least expensive given existing infrastructure, density, terrain and other factors. These estimates notwithstanding, this approach and the NBP are technologically neutral: These estimates do ***not*** reflect choices ***or*** recommendations that a particular last mile technology be utilized in any given area. Note, that as described later in this section in "**Creating the base-case scenario and output**," the focus in this analysis is on 12,000-foot-loop DSL and fixed wireless.

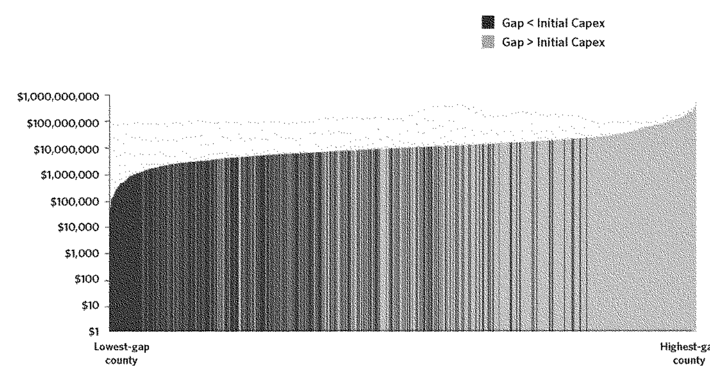
The map is somewhat misleading about the number of unserved housing units where wireline service is cheaper. In fact, while 42% of the geographic area is covered by counties where wired service has a lower gap, only 15% of counties with only 10% of the unserved housing units are in these areas; see Exhibit 1-J. Over time, these figures, which are based on the calculation of the investment gap for different technologies, may over- or under-estimate the role of any technology for a number of reasons. End-user behavior, specifically take rates or revenue per user, could differ from assumptions made in the model (see Chapter 3). In addition, the capabilities of different technologies could improve more or less quickly than assumed, or their costs could differ from what is modeled (see Chapter 4 for detail about capabilities and costs of different technologies). Finally, the impact of the disbursement mechanisms on individual service providers is impossible to include in these calculations.

The assumptions that underlie each of these calculations, and the method by which these technologies' costs are combined to reach the $23.5 billion gap, are discussed across the remainder of this document.

CREATING THE BASE-CASE SCENARIO AND OUTPUT

The base-case outputs, including the $23.5 billion gap, represent the shortfall of a particular combination of technologies across all unserved geographies. Since a single model run provides information about a single technology with a single set of assumptions, combining calculations for different technologies

Exhibit 1-G: Broadband Investment Gap, by County

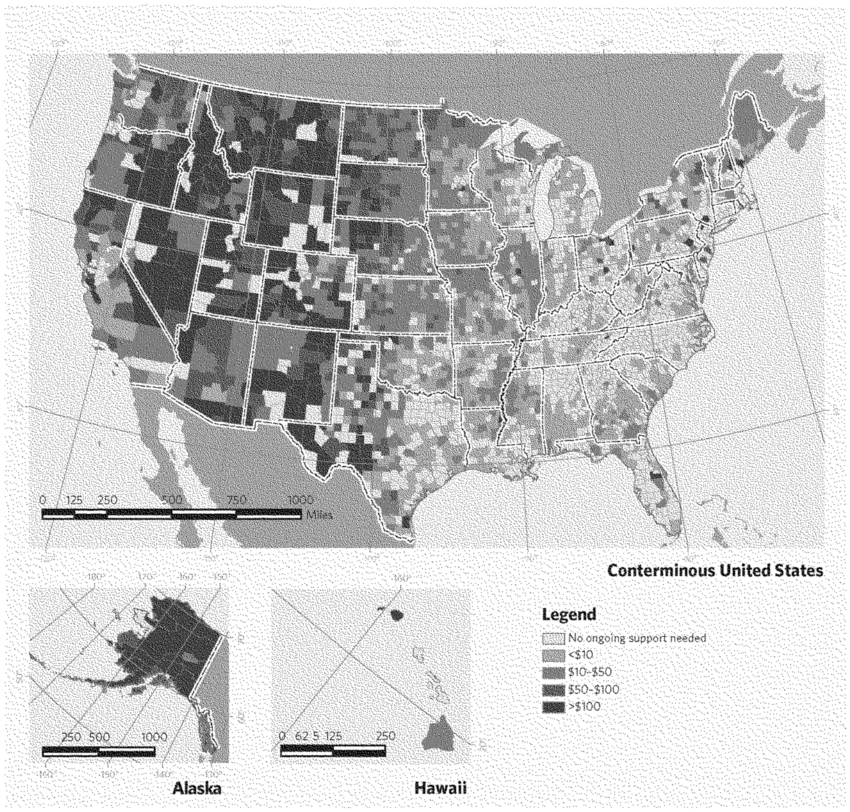


(USD, present value)

requires multiple model runs. This section describes the various models run as well as the manual post-processing required to create the single base case of $23.5 billion. Post processing of this type is required for each of the different scenarios and sensitivities shown in this document.

To create the base case, we calculate the gap for each of the two lowest-cost technologies: fixed wireless and 12,000-foot DSL (see Exhibit 4-C). Calculating the fixed wireless gap is quite complex, and requires eight different sets of model output. DSL is less complex, and requires only two sets of model

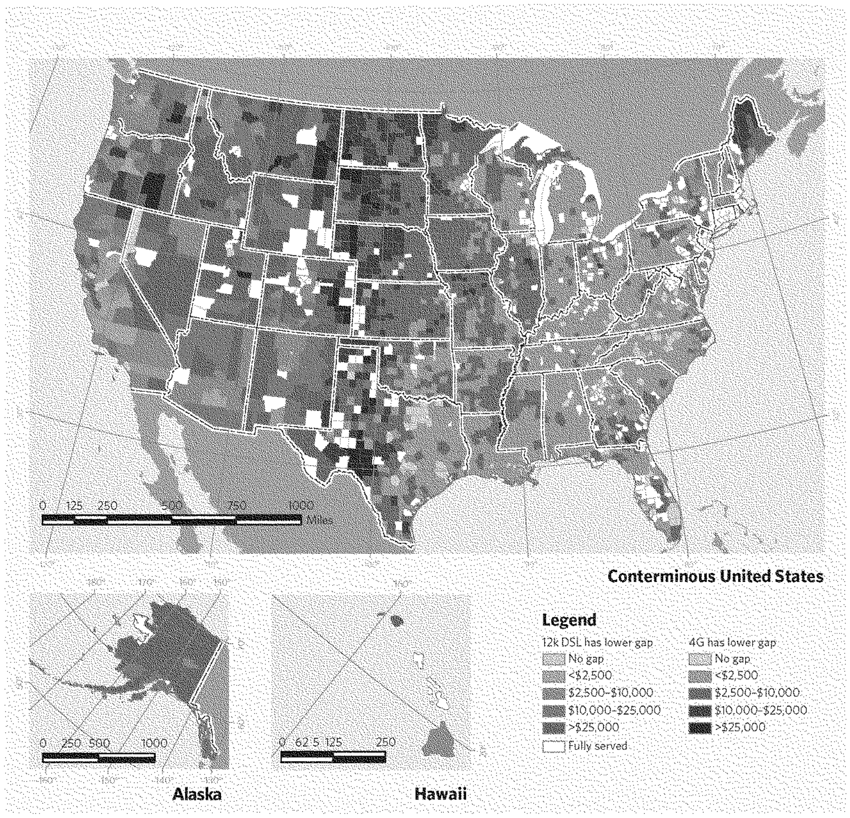
Exhibit 1-H:
Ongoing Support for Each Housing Unit per Month



output. Of course, we also calculate the gap for other technologies, which will be discussed in Chapter 4.

For wireless, we require a total of eight different runs to generate the output data and account for two different kinds of information: 1) the presence of planned commercial 4G deployments and 2) which of four different cell radii is required for each census block to provide adequate signal density given terrain-driven attenuation. The base case requires output for each combination.

Exhibit 1-I:
Investment Gap per Housing Unit by Lowest-Cost Technology for Each County



The first issue is the presence of commercial 4G deployments. A substantial fraction of the unserved are in areas we expect will be covered by commercial 4G build-outs. We treat these 4G and non-4G areas differently in our analysis to account for the costs and revenues associated with each and, consequently, need one run for each area. In 4G areas, as noted in the NBP, it is not clear whether these commercial build-outs will provide adequate service without incremental investments. The gap in these 4G areas needs to account for the fact that costs associated with the incremental investments are lower than they would be for a greenfield build. In non-4G areas, we calculate the costs for a greenfield build (note that, as will be discussed in the wireless portion of Chapter 3, we capture the cost savings available from existing cell sites, as appropriate).

Another key driver of the wireless gap is the cell radius in each area. Rather than assume a uniform cell radius across the entire country, the approach is to calculate the cost associated with different cell radii (two, three, five and eight-mile radii) and chose an "optimized" radius, which accounts for topology, for each area.

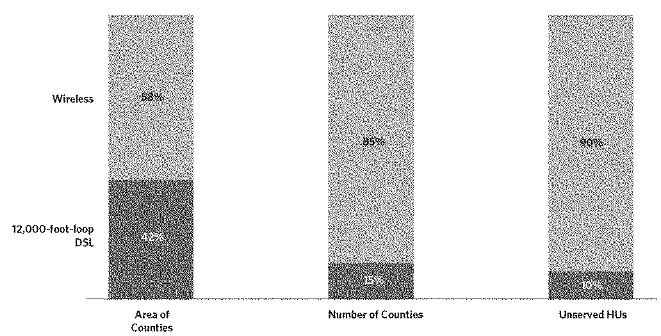
In total, then, there are eight wireless model runs: four runs (one for each radius) for the costs and gap associated with 4G areas; and four runs for the costs and gap associated with non-4G areas. For each geography (census block), we select the costs, revenues and gap from the appropriate run for each census block, depending on whether the area is in a 4G or non-4G area and what the optimized cell radius is.

The wired, 12,000-foot DSL solution is more straightforward and requires only two runs, which are required to account for the potential competitive impact of commercial 4G overlap on end-user revenue for the wired provider. While it is clear that a wireless carrier would need to make incremental investments to serve every unserved housing unit, wireless carriers will be able to serve some potentially large fraction of those within the commercial 4G footprint. Therefore, we assume that within the expected 4G footprint, DSL providers will face one fixed-broadband competitor (i.e., will split the end-user revenue with another carrier); in non-4G areas, we assume that DSL providers will not face any competition. The result is that the wired base case requires two model runs: one for 4G areas (with competition) and one for non-4G areas (without competition). The base case assumes wired solutions are all brownfield deployments where the incumbent builds out DSL service using existing twisted-pair copper.

The base case then involves calculating the lowest-cost and second-lowest-cost technology in each area. To make these comparisons at the service-area level (county level), we roll census blocks up into counties. These geographic roll-ups are made with Structured Query Language or SQL queries of the large, census-block-level output of the model and provide the essential outputs including costs, revenues and the gap for each model run or combination of model runs.

The model uses levelized costs and revenues. Levelization, often used in regulatory proceedings, calculates the annuitized equivalent—i.e., the effective annual value of cash flows—of the costs and revenues associated with building and operating a network. A levelized calculation provides a steady cash-flow stream, rather than trying to model or guess the timing of largely unpredictable yet sizable real-world payouts like those for upgrading and repairing equipment. The net present value (NPV) of a levelized cash flow is equal to the NPV of actual cash flows.

Exhibit 1-J.
Lowest Cost Technology



In order to calculate the Investment Gap as laid out in Exhibit 1-A, one need only make calculations from these market-level outputs. The three most important fields for this calculation are "contribution margin" (actually the levelized monthly gap, noting that a negative contribution margin represents a shortfall or positive gap), revenue (levelized monthly revenue) and initial capital investment.

First, determine the Investment Gap and total revenue by calculating the present value of the levelized contribution margin and revenue respectively. Second, calculate total cost by summing the present values for the investment gap and total revenue (moving from right to left in Exhibit 1-A). Third, the initial capital investment is provided in present value terms and can be taken directly from the query output. Finally, ongoing costs, which include all incremental capital expenses, operating expenses and any network residual value, are simply the difference between total cost and initial capital investment. These calculations are the same at any level of geographic aggregation, whether for the entire country or for any county.

CHAPTER 1 ENDNOTES

1 Note that this exhibit differs slightly from Exhibit 8-B of the first printing of the NBP. While the gap remains at $24 billion, the data in this paper are updated since the release of the NBP; future revisions of the NBP will include these updated data.

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II. BROADBAND AVAILABILITY

Before determining the size of the Investment Gap, it is necessary to determine the current state of broadband deployment. This includes the level of service currently supported (or which will be in the near-term without government support) as well as the proximity of unserved areas to broadband infrastructure that can be leveraged to serve the area.

The complexity of this analysis is driven by the need for a very granular geographic view of the capabilities of all the major types of broadband infrastructure as they are deployed today, and as they will likely evolve over the next three to five years without additional public support.

These data are not available: There is a lack of data at the required level of granularity, both in terms of which people have access to which services, and of which people are passed by different types of physical infrastructure. To solve this problem, we combine commercial and public data on availability and infrastructure with statistical techniques to predict or infer the data needed to complete our data set.

In some cases we use broadband availability data to predict the location of broadband infrastructure, and in some cases we use the location of broadband infrastructure to predict the availability of broadband capable networks. In areas where we do not have data, we combine data from other geographies with limited physical infrastructure data in a large multi-variant regression model. We use this regression model to predict availability by speed tier and to fill in gaps, especially last mile gaps, in our infrastructure data.

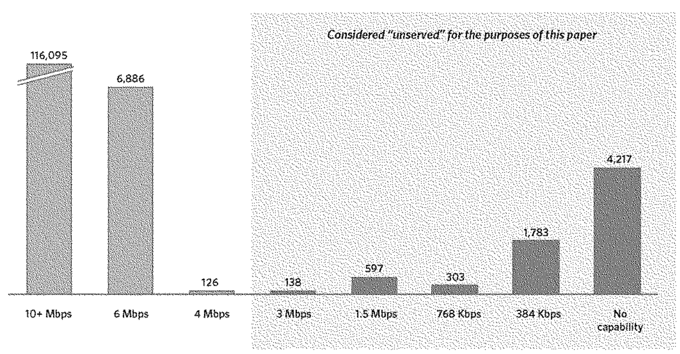
Once current availability is determined, we forecast the future state by relying on recent publicly announced network build-out plans.

Where the quality of data is limited, broadband-gap calculations will be affected. For example, there are 12 wire centers in Alaska that show no population within their boundaries and an additional 18 wire centers that have no paved public-use roads (i.e., no roads other than 4-wheel-drive or forest-service roads). All 30 of these wire centers were excluded from wired broadband-gap calculations; however, all areas with population were covered by the wireless calculations. In addition, due to insufficient demographic and infrastructure data to calculate baseline availability for Puerto Rico and the U.S. Virgin Islands in the Caribbean, and Guam, American Samoa and the Northern Marianas in the Pacific, these areas are excluded from further analysis.

CURRENT STATE

Although 123 million housing units already have broadband networks available that are capable of providing service that meets the National Broadband Availability Target of at least 4 Mbps download and 1 Mbps upload, many Americans do not. Currently, 7 million housing units representing 14 million people are left without broadband that meets the National Broadband Availability Target. See Exhibit 2-A.

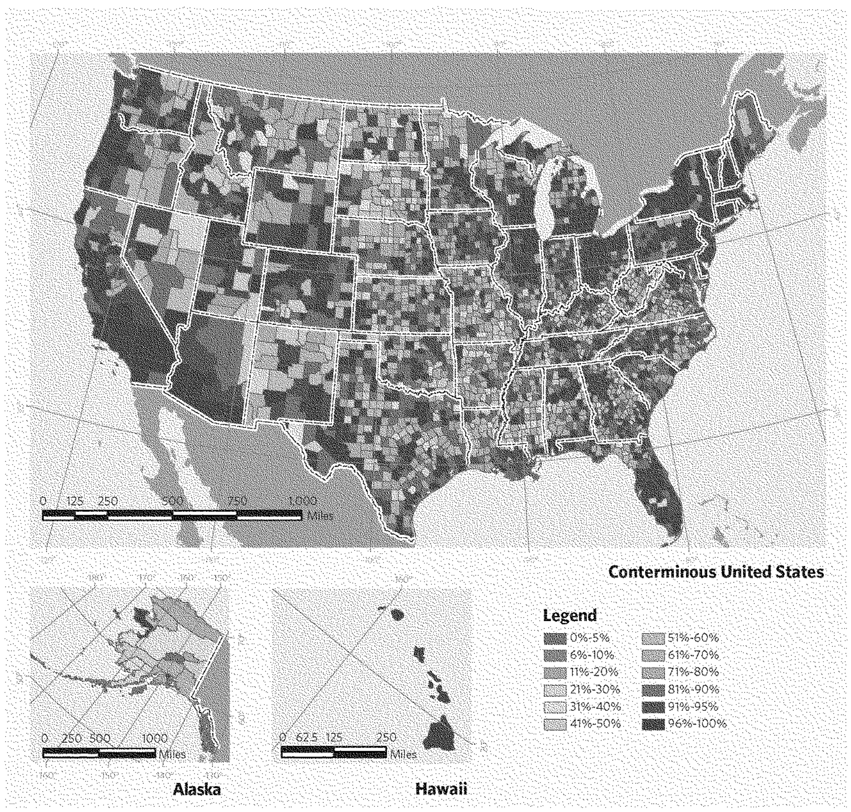
Exhibit 2-A: Highest Speed Capability of Available Wired Broadband Networks in the United States[1]



Housing units in thousands, downlink bit rate capability

Exhibit 2-B presents the distribution of these 7 million housing units across the United States. The number of un-served housing units in each county is calculated based on the methodology described below. That number is then divided by the total number of housing units in the county to get the percentage of homes served.

Exhibit 2-B:
Availability of Broadband Networks Capable of Meeting the National Broadband Target



Purpose of the Analysis

Before determining the size of the Investment Gap, it is necessary to determine who is unserved as well as the adjacent broadband infrastructure that could be leveraged to serve them. The distance and density dependencies of both current availability and the cost of providing service to those who do not currently have it required that we take into account the geography of each unserved area at a very granular level. That, in turn, requires that we create a geographically based view of current networks and broadband capabilities in order to calculate the Investment Gap.

Our current-state model calculates the likely broadband performance from multiple technologies at the census-block level to determine the highest level of broadband service available for each census block nationwide.

This model serves two main purposes:

- It determines the number and location of housing units and businesses that do not have broadband infrastructure available that meets our performance target.
- It provides the location of network infrastructure that can be used as the foundation for building out broadband networks to these unserved housing units; these infrastructure data provide an essential input into the economic model.

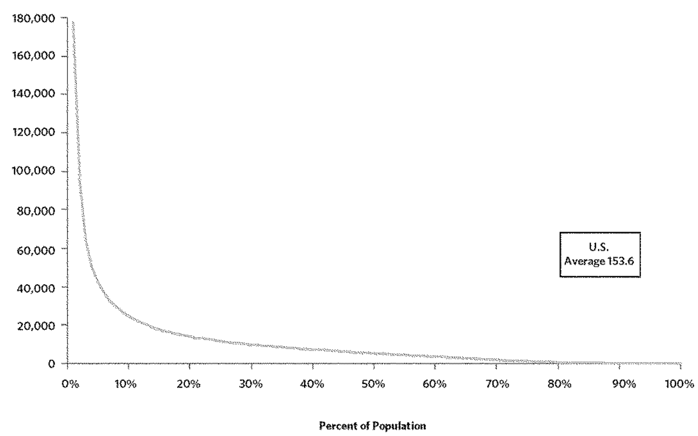
Number and location of the unserved

Once the availability of each network technology is determined at the census block level, we determine the highest speed broadband service available for each census block nationwide. Using this speed availability data and the national broadband target, we are able to determine what census blocks are currently "unserved." Then using census data for each block, we are able to determine the number of unserved housing units along with the demographic characteristics of the unserved.

Due to higher network costs per home passed, most of the unserved are located in less dense and/or rural areas. Although more sparsely populated states tend to have a larger portion of residents that are unserved, nearly every state has unserved areas. When examining the population density of the entire United States as in Exhibit 2-C, not just the unserved, one can see that a large portion of the population lives in areas of relatively low population density.

The average population density of populated census blocks in the United States is 153.6 people per square mile, though approximately three quarters of the population lives in areas of lower density. Unserved census blocks have a much lower density, with an average of only 13.8 people per square mile. The population density of the unserved follows a similar pattern to that of the country, with some areas being far more rural than others (see Exhibit 2-D). These areas of extremely low

Exhibit 2-C: Population Density of the United States, Per Square Mile of Inhabited Census Block



population density are some of the most difficult and expensive areas to serve.

The U.S. Census Bureau has categorized areas as urban areas, urban clusters and all other areas. Exhibit 2-E shows statistics of the unserved in terms of these definitions. As we can see, the deployment problem is one that predominantly exists outside of urban areas.

Since fixed broadband connects homes, not people, and most broadband networks are built along roads, either buried or on telephone/electric poles, an even more important driver of the cost to serve rural areas than population density is the number of road miles per housing unit of an area. Areas with more road miles per housing unit are even more likely to be unserved than areas of low population density. This is because the few homes in a rural area are sometimes clustered, which would decrease the number of road miles as well as the cost to serve.

The average number of road miles per housing unit in the United States is 0.07, which is much lower than the average unserved area of 0.41. But the average does not tell the whole story. A small portion of the population lives in areas with very high road-mile-to-housing-unit ratio, which tend to be the areas of the country that are unserved. Even within those unserved areas, there are portions that have an extremely high number of road miles per housing unit, which will be far more costly to serve than others. See Exhibits 2-F and 2-G.

Given the fact that the unserved are overwhelmingly in rural areas, one might expect that the unserved are in the territories of rural telecom companies. In fact, this is not the case: 52% of unserved housing units are in census blocks where one of the three Regional Bell Operating Companies, or RBOCs, (AT&T, Qwest or Verizon) is the dominant local exchange carrier; an additional 15% of unserved housing units are in census blocks

Exhibit 2-D: Population Density of the Unserved, Per Square Mile of Inhabited Census Block

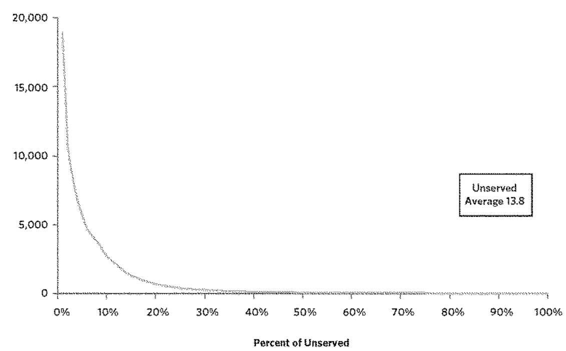


Exhibit 2-E: Statistics of Urban Areas/Clusters, and All Other Areas

Categories	AveragePeople/Sq. Mile	% of Population Unserved	# of Unserved Housing Units	Total Housing Units
Urban Areas/Clusters	2,900	1%	.7M	100M
All other areas	19	20%	6.3M	30M
Total	153.6	5%	7.0M	130M

Numbers do not sum due to rounding.

where a mid-size price-cap carrier is the dominant provider.[2] Only one-third of housing units are in census blocks where a rate-of-return carrier is the dominant provider.

Location of network infrastructure

We model each broadband network type independently to ensure a comprehensive view of infrastructure availability. Knowing where each type of network is currently deployed gives us the ability to calculate the incremental costs to upgrade the performance of an existing network as well as determine the likely location of middle and second mile fiber[3] that could be used to calculate the costs of deploying a new network.

There is a lack of comprehensive and reliable data sufficiently granular for the analysis we have described. To estimate the current state of broadband capable networks, we use the best available commercial and public data sources that meet our granularity, budget and timing requirements. We use infrastructure and speed availability data from a handful of states that were collected prior to the National Telecommunications and Information Administration (NTIA) mapping effort that is currently underway.[4] After evaluating numerous commercial data sets, we license the subset that best meets our needs.[5] We also examine Form 477 data and Form 325 data collected by the FCC but ultimately determine that these data are insufficiently granular.

The NTIA mapping effort will be complete in early 2011, and along with further revisions of the Form 477 data, they may be useful in refining our models in the future, but this will depend on the granularity of the data collected.

Network technologies modeled

The following sections include a description of our approach, data sources used, assumptions and risks for each of the three network technologies we modeled: cable, telco and wireless.

Cable

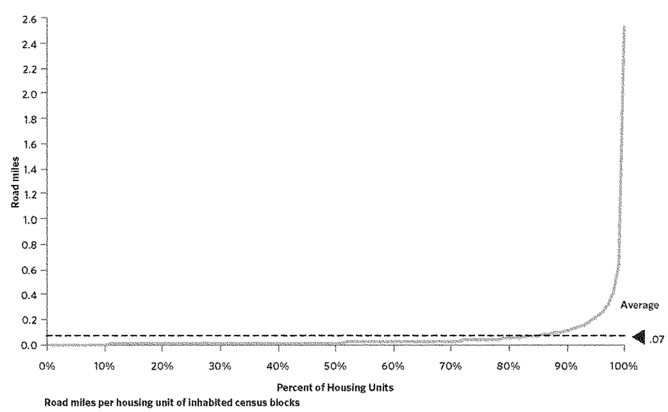
In order to determine broadband performance availability and infrastructure locations for cable networks, we use network availability data and estimated infrastructure locations based on cable engineering principles.

Data sources

In order to identify areas where cable broadband networks are located we license availability data from a commercial source[6] and collect publicly available infrastructure data from the state of Massachusetts.

We license a commercial data set from Warren Media called MediaPrints that provides data about nationwide availability of cable networks.[7] This data set includes geographic franchise boundaries as well as network capability information for cable

Exhibit 2-F: Linear Density of the United States, Ratio of Road Mile to Housing Units



operators nationwide. We use network capability information to exclude franchise areas where operators are still operating networks that have not been upgraded to provide two-way broadband access— i.e., we rely on a field indicating that the cable operator provides Internet services. Without detailed data on the specific services offered by each cable system, we have to make assumptions about one-way and two-way cable plant. We assume that all two-way cable plant is DOCSIS-enabled since we estimate the incremental revenue of providing broadband would likely exceed the DOCSIS upgrade costs once a cable network has been upgraded to two-way plant. We assume that the cost of upgrading areas with one-way cable to a network that supports broadband is equal to a greenfield build (i.e., we treat areas with one-way cable plant the same way we treat areas unserved by cable). We are also aware that MediaPrints may not include every cable network, but we believe the ones it excludes are smaller and are more likely to be one-way plants.

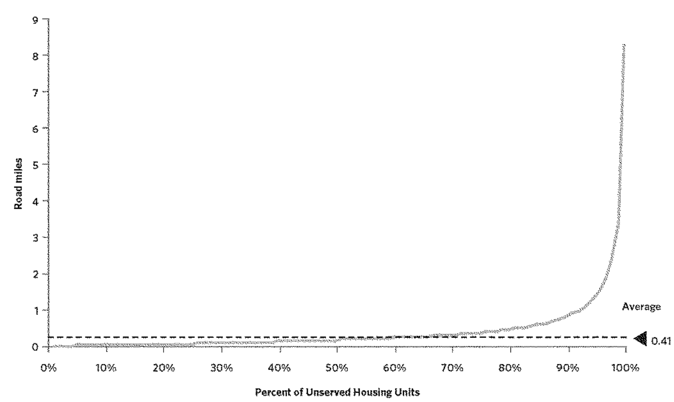
Another limitation is that the MediaPrints data do not allow us to distinguish between areas that have been upgraded from DOCSIS 2.0 to DOCSIS 3.0. In the absence of a data source that identifies the areas where DOCSIS 3.0 has been rolled out, we resort to mapping only the markets where we were able to find public announcements about DOCSIS 3.0 deployments at the time of analysis. This method understates the number of homes passed by DOCSIS 3.0 especially since the DOCSIS 3.0 rollouts proceeded quickly even as the analysis continued. But given that DOCSIS 2.0 areas exceed the broadband target speed of 4 Mbps download and 1Mbps upload, this underestimation does not affect the number of unserved or, therefore, the Investment Gap.

We are not able to acquire cable infrastructure data aggregated by any commercial or public source other than in the state of Massachusetts. These data are of limited use in the state of Massachusetts and, as we explain below, are of limited value for our nationwide analysis.

Risks

As stated previously, we may underestimate the number of housing units served in some areas since MediaPrints does not have data for every cable system, but we believe this number is small. This underestimation may be balanced by the fact that broadband availability is likely slightly overstated in the areas where MediaPrints has franchise data; this is due to the fact that cable operators do not typically build out service to every housing unit in their franchise area. We do not believe this overestimation to be significant because even large cable operators with large franchise areas tend to build out broadband to the vast majority of homes passed.[8] See Exhibit 2-H.

Exhibit 2-G: Linear Density of the Unserved, Ratio of Road Miles to Housing Units



Road-miles-per-housing-unit of uninhabited census blocks

We attempt to correct for this overestimation by comparing the MediaPrints franchise boundaries with actual cable strand maps from the state of Massachusetts.[9] In Massachusetts, operators must provide strand maps to the franchise board, which then publishes them into the public record. Unfortunately, with limited actual information available, we are unable to do a comprehensive comparison. As a result, there is not a pattern to the overestimation that could be applied nationwide.

Capabilities

As discussed in the section on hybrid fiber-coaxial (HFC) technology later in this document, we assume broadband-enabled cable networks are capable of delivering at least 10 Mbps actual download speeds, and those that have been upgraded to DOCSIS 3.0 are assumed to deliver 50 Mbps actual download.

Telco

Since we are not able to acquire a nationwide data set of either availability as a functon of broadband speed or telco infrastructure, we have to take a different approach to model telco. For telco networks we take a five-step approach to calculating availability nationwide:

1. Map availability data in areas where these data are available
2. Use telco infrastructure and engineering assumptions to estimate availability in areas where infrastructure data are available
3. Create a multivariable regression equation using demographic data (the independent variables) to predict broadband availability (the dependent variable), using states where availability data are available as sources for the regression
4. Apply regression equation to areas of the country where only demographic data exist to estimate speed availability
5. Use engineering principals and assumptions to infer infrastructure for estimated speed availability

Data sources

Although a nationwide data set of broadband availability consistent with the 4 Mbps download target is not available, there are a few states that have published availability data at different performance levels. The analysis relies on availability data from the states of California, Minnesota and Pennsylvania, and a combination of availability and infrastructure data is used from the states of Alabama and Wyoming.[10]

Some nationwide telco infrastructure data are used in conjunction with engineering principles and performance availability to more accurately estimate infrastructure locations. These data include locations of telco network nodes, such as central offices and regional tandems, from the Telcordia's LERG database, wire center boundaries from TeleAtlas and location of fiber infrastructure from GeoTel and GeoResults.

In addition to performance availability data and infrastructure data, demographic data are in the regression. These data are based on census forecasts from Geolytics for consumers and GeoResults for businesses.

We are forced to use a statistical model for telco plant because we are not able to acquire a nationwide data source of availability or telco infrastructure locations. An ideal data set for these purposes would focus on actual speed available (not on demand or subscribership), would be geographically granular (to distinguish among service speeds at longer loop lengths) and would provide information about the location of infrastructure (to feed into the economic model).

Unfortunately, no available data source meets all these requirements. Telcordia states that the CLONES database has the locations of all relevant telco infrastructure nationwide, but the FCC was not able to negotiate mutually agreeable license terms.

Data from the FCC's Form 477 are useful for many types of analysis; but, given that Form 477 data are collected at the census tract level, they are not granular enough to accurately estimate service availability and speed as noted in the September 2009 Open Commission Meeting. In the upper left

Exhibit 2-H: Cable Broadband Deployment for a Few Large MSOs as a Percentage of Homes Passed

Company	Cable Broadband Deployment (as of March 31, 2009)	Homes Passed (Millions)	Percent of Cable Homes Passed
Cablevision	100.0%	4.8	4%
Charter	94.9%	11.3	9%
Comcast	99.4%	50.6	40%
Mediacom	100.0%	2.8	2%
TWC	99.5%	26.8	21%

of Exhibit 2-I, we create an example of what perfect information on availability might look like. However, as noted in the lower left, Form 477 data provide information about the number of subscribers at a given speed, not the availability of service. Therefore, using Form 477 data to estimate availability requires making several assumptions as noted in the upper right of the exhibit. The result of these assumptions, as noted in the lower right, is that we are likely to overestimate the availability of service by relying on data collected at the census-tract level.

The ongoing efforts by states to map broadband availability, as coordinated by the NTIA as part of the Broadband Data Improvement Act[11] and funded by the Recovery Act,[12] may lead to a nationwide availability map that will be useful in this type of analysis, but the map will not be available until early 2011.

Statistical modeling where data did not exist

To estimate availability where no actual performance availability or infrastructure data exist, we create a regression equation that represents the relationship between demographic data and broadband availability data. The multivariable regression is based on more than 100 variables from population density to income levels to education levels. After determining how best to express the variables (in many cases by using their logarithms), initial models are estimated at all target speeds (ranging from 768 kbps to 6.0 Mbps) for each census block, using both forward and backward stepwise logistic regression. We use a logit regression rather than continuous so that we could use different variables and different weightings for each of the target speeds. Separate regressions are made for different speeds (768 kbps, 1.5 Mbps, 3.0 Mbps, 4.0 Mbps and 6.0 Mbps) inside and outside the cable franchise boundaries, for a total of 10 logit regressions. Accuracy rates among the 10 models were typically between 80% and 90%. Additional information on development of these statistical equations can be found in Attachment 4 of CostQuest Model Documentation.

We then use that series of statistical equations to predict broadband availability (from telco networks) at different speeds in each census block based on their demographics. This availability estimate is used to help determine what census blocks are unserved. Next, we estimate the location of network infrastructure necessary to provide that predicted level of service according to the approach outlined below. The network infrastructure location information generated by this current state model is fed into the economic model so the costs of upgrading and extending networks can be estimated accurately.

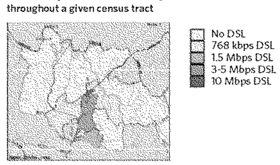
Risks

As with any statistical method, there will be errors (either over- or under-predicting the availability at a given speed) in any single, particular, small geography. However, we believe the results should be correct in aggregate. Even though we are able to achieve accuracy rates between 80% and 90% when we apply the regression to areas of known performance, the main risk in this approach is the possibility of systematic differences between the states for which we have data and the states for which we do not.

Since the statistical regression relies on a small number of states, to the extent that the tie between demographics and

Exhibit 2-I: Assumptions Required to Use Tract-Level Data Likely Overestimate Availability

It is unlikely that service is evenly distributed throughout a given census tract



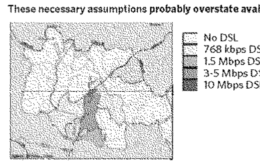
Form 477 was not designed to address this distribution question

Census tract	Housing Units	Total ADSL subs	ADSL: 768k-1.5Mbps	ADSL: 1.5-3.0Mbps	...
3749265	1,229	208	6	97	

As a result, minimal assumptions are necessary in order to make any estimate

1. Service available anywhere in a tract is available to every housing unit (HU) in that tract
2. The speed provided to the highest-speed HU in each tract is available to every HU in that tract

These necessary assumptions probably overstate availability



Sources: Census Bureau; March 2009 Form 477 data; OBI analysis network availability in the rest of the country is not the same as these states, the regression will not be accurate. The states we used in our analysis have a wide variety of rural and urban areas and have varied geographic challenges which are advantageous, but there is no way to verify our outputs without additional data.

Aligning infrastructure with availability data

We estimate the current state of broadband-capable networks using speed availability data and infrastructure data. In the areas where we have infrastructure data we use engineering assumptions to estimate speed availability. In areas where we have availability by speed we use engineering assumptions to estimate the likely location of infrastructure. In this way we are able to estimate both availability by speed and infrastructure locations nationwide.

Exhibit 2-J illustrates these two approaches. On the right-hand side is an illustration of determining speed availability from infrastructure. Imagine that data indicate the presence of a Digital Subscriber Line Access Multiplexer (DSLAM) at No. 1. Using the location of the DSLAM as a starting point, we can trace out a distance along road segments that corresponds to availability for a given speed; for 4 Mbps service, that distance is approximately 12,000 feet.

On the left-hand side is an illustration of determining infrastructure from speed availability. Imagine that we have data for the area shaded in blue that indicates it has 4 Mbps DSL. We know then that homes can be a maximum of 12,000 feet from a DSLAM. Standard engineering rules, combined with clustering and routing algorithms, allow the model to calculate the likely location of efficiently placed infrastructure. See CostQuest Model Documentation for more information.

Wireless

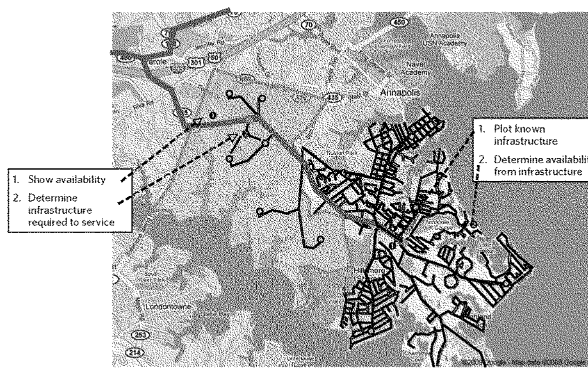
We rely on a nationwide data set of performance availability for wireless networks as well as infrastructure data in the form of tower site locations. With these two data sets we are able to estimate current availability as well as potential infrastructure locations that could be used to deploy into unserved areas. We do not create a full propagation model but rather, rely on coverage data to determine availability.

Data sources

In order to identify areas where wireless networks are located, we license a commercial data set from American Roamer. This data set provides wireless coverage by operator and by network technology deployed. The wireless technology deployed allows us to estimate the speeds available. As noted in the National Broadband Plan, American Roamer data may overstate coverage actually experienced by consumers as they rely on advertised coverage as provided by many carriers, who may all use different definitions of coverage. These definitions may differ on signal strength, bitrate or in-building coverage.

American Roamer only recently started mapping Wireless Internet Service Providers (WISP) coverage and estimates it has mapped only 20% of WISPs. We do not include WISP coverage in our model due to the current scarcity and reliability of the data.

Exhibit 2-J: Aligning Infrastructure with Availability



Like telco infrastructure, wireless infrastructure location information (typically towers) is fed into the economic model so the costs of upgrading and extending networks can be calculated accurately. We used Tower Maps data to identify the location of wireless towers in unserved areas that could be used for fixed wireless deployments.

Risks

We potentially overstate the current footprint because what is commercially available is typically based on carrier reported data, perhaps at relatively low signal strength. Overstating the current footprint could lead us to underestimate the cost of future wireless build outs to provide service to the areas currently unserved.

FUTURE STATE

We do not expect the number of unserved housing units to decline materially between now and 2013. Our analysis indicates that most unserved areas are NPV negative to serve with broadband, and so we have made the conservative assumption that there will be few new or upgrade builds in these areas. While significant investments are being made to upgrade the speed and capacity of broadband networks, those investments tend to be made in areas that are already well served. Moreover, those network upgrades are not ubiquitous throughout currently served areas. Therefore, as applications become more advanced and higher performance networks are required—i.e., if the broadband target grows significantly over time—the number of people with insufficient broadband access may actually increase.

Wired network upgrades

Both telephone and cable companies are upgrading their networks to offer higher speeds and greater-capacity networks. Cable companies are upgrading to DOCSIS 3.0, which will allow them to transfer to broadband some of the network capacity that is currently used for video. Telephone companies are extending fiber closer to end-users, in some cases all the way to the home, in order to improve the capacity and speed of the network. Besides providing a faster, higher-capacity broadband network, once fiber is within approximately 5,000 feet of the home, the network has the ability to offer multi-channel video services in addition to broadband and voice.

The Columbia Institute for Tele-Information recently released a report called "Broadband in America" in which it tried to identify as many of the major publically announced network upgrades as possible. Verizon has announced that it plans to pass 17 million homes by 2010 with its fiber-to-the-premises (FTTP) service called FiOS.[13] Many other small incumbent local exchange carriers (ILECs) also plan to aggressively build FTTP networks where it makes financial sense.[14] AT&T has announced that it will build out FTTN to 30 million homes by 2011.[15] This means that at least 50 million homes will be able to receive 20 Mbps+ broadband from their local telco within the next two years. The cable companies have also announced upgrades to DOCSIS 3.0 over the next few years with analysts predicting cable operators will have DOCSIS 3.0 covering 100% of homes passed by the end of 2013.[16] Exhibit 2-K highlights some of the major publicly announced upgrades to wired broadband networks.

As shown in Exhibit 2-L, for proven technologies, when operators publically announce plans to upgrade their network, they tend to complete those builds on time.

Using these public announcements and our current availability assessment, we create a forecast of wired broadband availability in 2013. We assume that FTTP and upgrades will take place in markets with cable that will be upgraded

Exhibit 2-K: Publicly Announced Wired Broadband Upgrades

Technology	Companies	2009	2010	2011
FTTP	• Verizon • Cincinnati Bell • Tier 3 ILECs	• All providers (17.2MM—as of Sept) • Verizon FiOS (14.5MM- as of June)	• Verizon FiOS (17MM)	
FTTN	• AT&T • Qwest	• Qwest (3MM)	• Qwest (5MM)	• AT&T U-verse (30MM)
DOCSIS 3.0	• Comcast • Cablevision • Cox • Knology • Time Warner • Charter • Mediacom • RCN	• Comcast (40MM) • Charter (St. Louis) • Mediacom (50% of footprint) • Knology (50% of footprint) • RCN (begin deployment)	• Comcast (50MM) • Cablevision (entire footprint) • Cox (entire footprint) • Time Warner (New York City) • Knology (entire footprint)	

Exhibit 2-L:
With the Exception of Satellite, Most Announced Broadband Deployments are Completed on Schedule

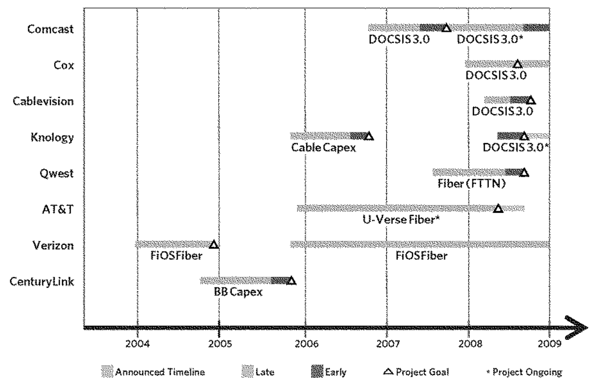
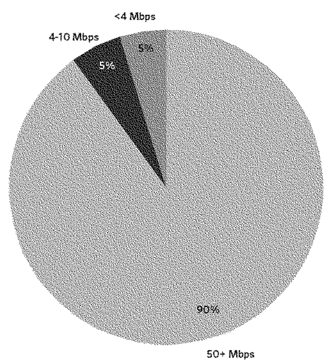


Exhibit 2-M:
Projected 2013 Availability of Broadband Capable Networks



Fastest downlink speed capability of broadband networks
Percent of U.S. population with network availability, Mbps

to DOCSIS 3.0. Therefore, as Exhibit 2-M shows, all of the announced upgrades will likely take place in areas that were already served. Without government investment, the difficult-to-reach areas will remain unserved while the rest of the country receives better broadband availability.

Wireless network upgrades

The wireless broadband networks are still in the nascent stages of development and continue to evolve rapidly with new technologies, applications and competitors.

Many operators still have significant areas covered by 2G technologies but have already announced upgrades to 4G data networks. Mobile operators are investing heavily in network upgrades in order to keep pace with exploding demand for mobile data services.

By 2013, Verizon plans to roll out Long Term Evolution (LTE) technology to its entire footprint, which covered 288 million people at the end of 2008.[17] AT&T has announced that it will undertake trials in 2010 and begin its LTE rollout in 2011. Through its partnership with Clearwire, Sprint plans to use WiMAX as its 4G technology. WiMAX has been rolled out in few markets already and Clearwire announced that it plans to cover 120 million people by the end of 2010.

For well-known technologies, when operators publically announce plans to upgrade their network, they tend to complete those builds on time. However, as was the case with WiMAX, when a technology is still being developed, technological issues can significantly delay planned deployments. LTE is an example of a new wireless technology that has not been deployed yet commercially on a wide scale so we must be cautious about planned deployment schedules.

As we discuss later in this document these commercial 4G build outs may not fully meet the National Broadband Availability Target without incremental investment; but the commercial investments in these deployments will certainly improve the incremental economics of 4G fixed wireless networks in those areas.

Due to the lack of geographic specificity and overlapping coverage areas we were not able to precisely forecast future wireless coverage speeds that will be available in years to come based on public announcements.

Satellite network upgrades

The capacity of a single satellite will increase dramatically with the next generation of high throughput satellites (HTS) expected to be launched in the next few years. ViaSat Inc., which acquired[18] WildBlue Communications in December 2009, and Hughes Communications Inc. plan to launch HTS in 2011 and 2012, respectively.[19,20] These satellites each will have a total capacity of more than 100 Gbps, with some designated for upstream and some for downstream. After the launch of the new satellites, ViaSat expects to offer 2-10 Mbps downstream while Hughes suggests it will offer advertised download speeds in the 5-25 Mbps range.[21] Despite this additional capacity, our analysis suggests it will be insufficient to address more than 3.5% of the unserved. See Chapter 4 on satellite.

Conclusion

While such investments in technology and broadband networks may help bring faster speeds to those who are already served, and could potentially reduce the average cost per subscriber, it is far from certain that they will decrease the number of unserved.

Exhibit 2-N:
Publicly Announced 4G Wireless Deployments

Technology	Companies	2009	2010	2011	By 2013
LTE	• Verizon • AT&T • MetroPCS • Cox		• Verizon (100MM) • AT&T (Trials)	• AT&T (start deployment) • Cox (start deployment) • MetroPCS (start deployment)	• Verizon (entire network)
WiMAX	• Clearwire • Open Range • Small WISPs	• Clearwire (30MM) • WISPs (2MM)	• Clearwire (120MM)		• Open Range (6MM)

Exhibit 2-O:
Specific Company Historical Performance Against Announced Completion Dates

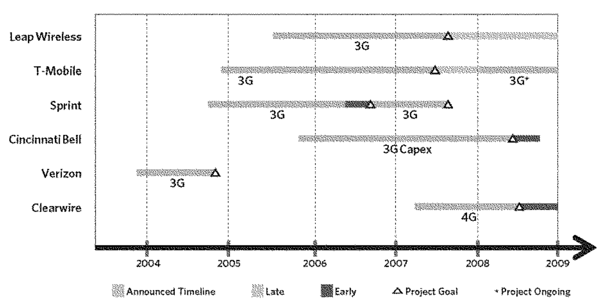


Exhibit 2-P:
Publicly Announced Total Near Term Satellite Broadband Capacity[22]

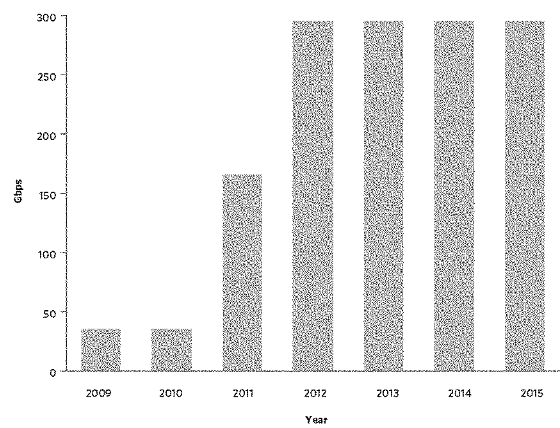


Exhibit 2-Q:
Commercial Data Sources Used to Calculate Availability

Vendor	Database	Use
American Roamer	Advanced Services	Wireless service footprint
Geolytics	2009 block estimates	Block level census estimates
	Estimates professional	Block group level estimates
GeoResults	National Business Database	Fiber served building (flag); business locations and demographics
GeoTel(imap)	MetroFiber	Metro Fiber Routes (GDT and Navteq)
	LATA Boundaries	Used for middle mile map to group switches into latas
	Fiber Lit Buildings (point)	Used to flag wire center boundaries as likely having fiber infrastructure
Telcordia	LERG	Switch office locations
TeleAtlas	Wire center boundaries	Wire center boundaries, domswitch, OCN, carrier name
	Zip code boundaries	Zip code boundaries
Tower Maps		Location of towers and sites
Warren Media	Warren Media	Cable-franchise boundary (by block group)

Exhibit 2-R:
Public Data Sources Used to Calculate Availability

Data Source	Database	Location
Alabama	State broadband availability	http://www.connectingalabama.com/ca/maps.aspx <http://www.connectingalabama.com/ca/maps/CBResults072909.zip>
California	State broadband availability	ftp://ftp.cpuc.ca.gov/Telco/Existing_Broadband_Service_Aggregated_072409.zip
Pennsylvania	State broadband availability	Available from Technology Investment Office
Minnesota	State broadband availability	Available from Technology Investment Office
Wyoming	State broadband availability	Available from State CIO
US Census	Tiger 2008	Blocks, Counties, Roads, Block Group Boundaries
	SF1	Summary File 1, US Census 2000
	SF3	Summary File 3, US Census 2000
FCC	Varies	Market Data Boundaries (adjusted for Census County Updates)
NECA	Tariff 4	PDF as filed 9/2009
Congressional Districts	110 Congress	http://www.nationalatlas.gov/atlasftp.html?openChapters=chpbound#chpbound

CHAPTER 2 ENDNOTES

1. DOCSIS 2.0 is capable of delivering ~10 Mbps, while DOCSIS 3.0 is capable of delivering ~50 Mbps. FTTN and FTTP can offer speeds well over 6 Mbps; however, the statistical-regression methodology used to estimate availability as a function of speed, combined with the source data for that regression, do not allow us to make estimates for telco-based service above 6 Mbps. *See* the Telco portion of this section for more detail.
2. Mid-size carriers include Alaska Communications Systems, CenturyLink, Cincinnati Bell, Citizens Communications, Consolidated Communications, FairPoint Communications, Hawaiian Telecom, Iowa Telecom and Windstream.
3. *See* Exhibit 4-BT for a description of middle versus second mile.
4. The Broadband Data Improvement Act (BDIA), Pub. L. No. 110-385, 122 Stat. 4096 (2008).
5. *See* Exhibits 2-Q and 2-R for a complete list of licensed data that we used.
6. *See* Warren Media MediaPrints database, http://www.mediaprints.com/index.htm (accessed Aug. 2009) (on file with the FCC) (Warren Media database).
7. *See* Warren Media MediaPrints database
8. ROBERT C. ATKINSON & IVY E. SCHULTZ, COLUMBIA INSTITUTE FOR TELE-INFORMATION, BROADBAND IN AMERICA: WHERE IT IS AND WHERE IT IS GOING (ACCORDING TO BROADBAND SERVICE PROVIDERS) at 57 (2009) ("CITI BROADBAND REPORT"), available at http://www4.gsb.columbia.edu/citi/.
9. Massachusetts General Laws Chapter 166A § 4 states, in part: "each applicant shall set forth as completely as possible the equipment to be employed, the routes of the wires and cables, the area or areas to be served." Upon its own investigation (Investigation of the Cable Television Division of the Department of Telecommunications and Energy on its Own Motion to Review the Form 100, CTV 03-3, November 30, 2004), the department (which became known as the "Department of Telecommunications and Cable" in April 2007) found, in part, at pages 18-19, that the statutory requirement referred to above is meant to promote "general use," and finds that "a strand map identifying the presence and location of the cable system within a specific community is sufficient to satisfy the statutory requirement." This order also finds that an issuing authority (a municipality) may request more detailed, technical information about a cable system than the cable plant map is required for general use, provided it is willing to enter into a non-disclosure agreement with the cable operator if requested.
10. Infrastructure data were not accessed by the FCC directly but were analyzed for the FCC by a contractor with access to these data.
11. The Broadband Data Improvement Act (BDIA), Pub. L. No. 110-385, 122 Stat. 4096 (2008).
12. American Recovery and Reinvestment Act of 2009, Pub.L. No. 111-5, § 6001(k)(2)(D), 123 Stat. 115, 516 (2009) (Recovery Act).
13. CITI BROADBAND REPORT AT 7.
14. CITI BROADBAND REPORT AT 7.
15. CITI BROADBAND REPORT AT 7.
16. T. McElgunn, "DOCSIS 3.0 Deployment Forecast," Pike & Fischer, 2009.
17. CITI BROADBAND REPORT AT 8.
18. On October 1, 2009, ViaSat announced it had signed a definitive agreement to acquire privately held WildBlue. On December 15, 2009, ViaSat announced the completion of the announced acquisition; see ViaSat, WildBlue Communications Acquisition Closes, http://www.viasat.com/news/wildblue-communications-acquisition-closes (last visited Feb. 12, 2010).
19. Letter from Mark Dankberg, Chairman & CEO, ViaSat, to Blair Levin, Executive Director of OBI, FCC, GN Docket Nos. 09-47, 09-51, 09-137 (Jan. 5, 2010) ("ViaSat Jan. 5, 2010 Ex Parte") at 2.
20. Letter from Stephen D. Baruch, Counsel for Hughes Communications, Inc., to Marlene H. Dortch, Secretary, FCC (Oct. 26, 2009) ("Hughes Oct. 26, 2009 Ex Parte") at 6.
21. CITI BROADBAND REPORT AT 57.
22. Note that this forecast only includes publicly announced launches and not additional, planned launches that are likely. *See* Northern Sky Research, How Much HTS Capacity is Enough? (2009), http://www.nsr.com/AboutUs/PressRoom.html (last visited Jan. 20, 2010).

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III. CALCULATING THE INVESTMENT GAP

To calculate the amount of money required to offer service in areas that would otherwise remain unserved, we must make a number of decisions about how to approach the problem, design an analysis that accurately models the problem and make a number of assumptions to conduct the analysis. To this end, we created an economic model to calculate the lowest amount of external support needed to induce operators to deploy broadband networks that meet the National Broadband Availability Target in all unserved areas of the country.

KEY PRINCIPLES

The FCC developed its broadband economic model to calculate the gap between likely commercial deployments and the funding needed to ensure universal broadband access. Underlying the model's construction are a number of principles that guided its design.

- **Only profitable business cases will induce incremental network investments.**
- **Investment decisions are made on the incremental value they generate.**
- **Capturing the local (dis-)economies of scale that drive local profitability requires granular calculations of costs and revenues.**
- **Network-deployment decisions reflect service-area economies of scale.**
- **Technologies must be commercially deployable to be considered part of the solution set.**

Only profitable business cases will induce incremental network investments. *Private capital will only be available to fund investments in broadband networks where it is possible to earn returns in excess of the cost of capital. In short, only profitable networks will attract the investment required. Cost, while a significant driver of profitability, is not sufficient to measure the attractiveness of a given build; rather, the best measure of profitability is the net present value (NPV) of a build. This gap to profitability in unserved areas is called the Broadband Availability Gap in the NBP; throughout this paper, we will refer to this financial measure as the Investment Gap.*

The calculation of the $23.5 billion Investment Gap is based on the assumption that the government will not own or operate the network itself, but rather will provide funding to induce private firms to invest in deploying broadband. This is primarily because private firms can provide broadband access more efficiently and effectively due to their ownership of complementary assets and experience in operating networks. By subsidizing only a portion of the costs, the government provides the markets with the incentive to continue to innovate and improve the efficiency of buildouts and operations. In addition, since private firms will be investing a significant portion of the costs, the amount of public money required is greatly reduced.

Simply calculating the incremental costs of deploying broadband is not enough to determine the Broadband Investment Gap necessary to encourage operators to deploy. To ensure that firms seeking an adequate return on their invested capital will build broadband networks in unprofitable areas, we solve for the amount of support necessary to cause the networks' economics to not only be positive, but to be sufficiently positive to motivate investment given capital scarcity and returns offered by alternative investments.

The model assumes an 11.25% discount rate; by calculating the NPV gap as the point where NPV = 0, we equivalently set the internal rate of return (IRR) of these incremental broadband buildouts to 11.25%. This rate is the same one determined by the FCC in 1990 to be an appropriate rate for telecom carriers earning a rate of return on interstate operations.[1]

In order to determine the level of support needed to encourage operators to build broadband networks, we identify the expected cash flows associated with building and operating a network over the project's lifetime of 20 years. Next, we compute the NPV of those cash flows to arrive at the Investment Gap. In other words, the gap is the present value of the amount by which operators fail to produce an 11.25% IRR. It is important to note that ongoing expenses include incremental deployment and operational costs (initial capex, ongoing and replacement capex, opex, SG&A) as well as depreciation, cost of money and tax components for an incremental broadband investment; revenues include all incremental revenue from the modeled network with average revenue per user (ARPU) and take rates calculated as discussed below. As a result, when the NPV analysis yields a value of zero, it means that the project's revenues are sufficient to cover all expenses while providing a rate of return on invested capital of 11.25%.

In fact, if a carrier has a weighted-average cost of capital (WACC) above the 11.25% rate, even a guarantee to reach the 11.25% IRR would not cause it to build.

In contrast, if a carrier has a WACC lower than 11.25%, it will earn profits above the 11.25% IRR proportional to the size of the spread between WACC and discount rate. Having the IRR above WACC does not necessarily mean that operators are earning outsize returns, however. Since the support level is based on forecasts of both revenue and cost across the lifetime of the asset, carriers are taking on significant risk by investing or committing to invest in network maintenance and operations. The extent to which IRR provides returns in excess of WACC reflects the operational risk of providing service in unserved areas, where the economics are generally unfavorable. Service providers are likely to have other investment opportunities with strong risk-return profiles at their WACCs.

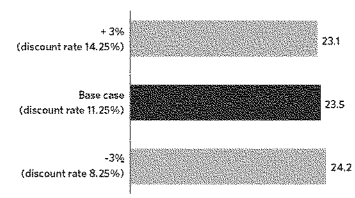
One result of this execution risk is that carriers with WACC below the 11.25% discount rate might tend to favor a guaranteed annuity over time that would lock in the 11.25% return. Receiving support as an upfront payment, either in whole or in part, would require the operator to take on this higher execution risk, making the investment potentially less attractive.

After receiving the one-time payment, the telecom operators can reinvest the funds in their operations. Investments that yield a return above 11.25% will result in an economic benefit to the telecom provider.

Since the operators in any specific area, their associated WACCs and the disbursement mechanism are all unknown at this point, we make the simplifying assumption that carriers will be indifferent to receiving an upfront one-time payment, a series of payments over time or a combination of the two.

While the discount rate typically has significant impact on the NPV of a project, in this case the impact is mitigated for two main reasons. First, initial capital expenditures, which take place at the start of the project and, therefore, are not discounted, account for 65.1% of the Broadband Investment Gap. Second, because revenue and ongoing costs offset one another to a large extent (see Exhibit 1-A), the impact of changes in the discount rate is small. As shown in Exhibit 3-A, even significant changes in the discount rate (of up to 300 basis points) yield modest changes in the base-case Investment Gap of less than $1 billion.

Exhibit 3-A:
Impact of Discount Rate on Investment Gap



Time horizon for calculations

Calculating the value of long-life investments such as fiber builds or cell-site construction requires taking one of two approaches: explicitly forecasting and modeling over the entire useful life of the asset, or calculating either the salvage value of remaining assets or the terminal value of operations. Although neither choice is optimal, we use a 20-year explicit model period, which corresponds to the long-life assets in broadband networks. We do not include any terminal or salvage value at the end of a shorter explicit forecast period.

Calculating the ongoing terminal value of operations in this context is challenging at best since the modeled cash flows never reach a steady state. As we note below, when describing key assumptions, the take rate grows across the entire calculation period, and levelized take rate for a five- or 10-year forecast dramatically understates the final take rate. The result is that a terminal value calculation will not accurately reflect the ongoing value generated by the investment. Consequently, we must explicitly model over the full 20-year life of the network assets. Although utilizing a 20-year forecast is not atypical for businesses making capital planning decisions, such forecasts obviously require making speculative long-range assumptions about the evolution of costs and revenues.

It is also worth noting that the calculation models the value of an incremental broadband network investment, not the value of the company. Consequently, we assume that at the end of the 20-year explicit period there is no substantial value remaining for two reasons. First, from the accounting perspective—and based on an estimate of actual useful life[2]—most of the assets have been fully depreciated, and those that have some value remaining only have value in a fully operating network. Second, from a technological perspective, it is unclear that there will be any incremental value from the existing 20-year-old network relative to a greenfield build.

Investment decisions are made on the incremental value they generate. *While firms seek to maximize their overall profitability, investment decisions are evaluated based on the incremental value they provide. In some instances, existing assets reduce the costs of deployment in a given area. The profitability of any build needs to reflect these potential savings, while including only incremental revenue associated with the new network buildout.*

The model takes existing infrastructure into account and only calculates the incremental costs and incremental revenues of deploying broadband. This means that in most areas the costs of offering broadband are the costs associated with upgrading the existing telco, cable or wireless network to offer broadband. Exhibit 3-B illustrates the incremental buildout for a telco network. This minimizes support and is consistent with how firms typically view the sunk costs of existing infrastructure.

The full cost of the network is necessary only in areas that require a greenfield build, i.e. in areas with a complete lack of infrastructure or when the greenfield build of one technology has a lower investment gap than upgrading an existing network. Revenues are treated the same way as costs. Only the incremental revenues associated with new services are used to offset costs in the calculation of the gap.

For example, millions of homes are already "wired" by a telephone network with twisted pair copper lines that provide voice telephony service. These telephone networks require only incremental investments to handle digital communications signals capable of providing broadcast video, broadband data services and advanced telephony. Incremental costs of upgrading these networks include investments in: fiber optic cable and optic/electronics in large portions of the copper plant, the replacement and redesign of copper distribution architecture within communities to shorten the copper loops between homes and telephone exchanges, the deployment of new equipment in the exchanges and homes to support high capacity demands of broadband, and sophisticated network management and control systems. The incremental revenues are the revenues associated with the newly enabled broadband and video services.

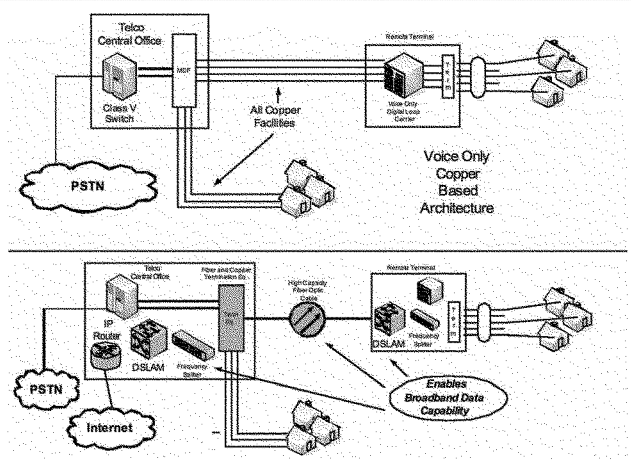
One issue with this approach is that it assumes that existing networks will be available on an ongoing basis. To the extent that existing networks depend on public support, such as USF disbursements, the total gap for providing service in unserved areas could be significantly higher than the incremental calculation indicates.

For the purposes of the financial model, we consider only incremental revenue, which is the product of two main components: the number of incremental customers and ARPU.

The number of incremental customers is based on the technology that is ultimately implemented. Throughout the modeling process, we take care to not "double-count" revenues for operators who upgrade their existing networks with broadband data or video capabilities. For example, if an incumbent telco decides to shorten loop lengths in order to deliver data and video services, only incremental data and video-related revenue should be considered. Incremental revenues from voice products will not be considered since those products are already being offered. Exhibit 3-C shows which products are considered to be incremental for each technology.

Capturing the local (dis-)economies of scale that drive local profitability requires granular calculations of costs and revenues. *Multiple effects, dependent on local conditions, drive up the cost of providing service in areas that*

Exhibit 3-B: Incremental Network Elements Necessary to Upgrade a Telephone Network to Offer Broadband



currently lack broadband: Lower (linear) densities and longer distances drive up the cost of construction while providing fewer customers over whom to amortize costs. At the same time, lower-port-count electronics have higher costs per port. In addition, these lower densities also mean there is less revenue available per mile of outside plant or per covered area.

Using the average cost per household of existing deployments, even when adjusted for differences in population density, presents a risk that costs may be underestimated in rural areas. Even when considering local population and linear densities, costs in many rural markets will be subscale, rendering inaccurate a top-down analysis of average costs. Attempting to calculate profitability without taking these variations into account—for example by extrapolating from cost curves in other areas—would necessarily lead to questionable, or even misleading, conclusions. Therefore, we take a bottom-up approach that provides sufficient geographic and cost-component granularity to accurately capture the true costs of subscale markets.

An example of this is evident when we consider the cost allocation of a digital subscriber line access multiplexer (DSLAM) chassis in an area with very low population density. If only one home is connected to the DSLAM, the entire cost of that DSLAM should be allocated to the home rather than a fraction based on the DSLAM capacity. In order to calculate the costs with this level of accuracy, we need geographic and cost-component granularity throughout. Accounting for granularity with respect to geography is particularly important because so many network costs are distance dependent. Calculations are needed at a fine geographic level; therefore, we model the census block as the basic geographic unit of calculation.[3]

Capturing cost-component granularity is important due to the fixed-cost nature of network deployments. For example, one must capture the costs associated with trenching fiber facilities, which are shared among many end-users, differently than the cost associated with line cards and installation, which may be directly attributed to a given customer. We provide more details about the cost calculations of each technology in Chapter 4.

Network-deployment decisions reflect service-area economies of scale. *Telecom networks are designed to provide service over significant distances, often larger than 5 miles. In addition, carriers need to have sufficient scale, in network operations and support, to provide service efficiently in that local area or market. Given the importance of reach and the value of efficient operations, it can be difficult to evaluate the profitability of an area that is smaller than a local service area.*

Though geographic granularity is important in capturing the real costs associated with providing broadband service in rural and remote areas, it does not make sense to evaluate whether to build a network at the census block level. Rather, the modeling needs to capture deployment decisions made at a larger, aggregated "service area" level.

Using the census blocks as a market is problematic for several reasons. First, telecom infrastructure typically has some efficient scale length associated with it. For wireless, that distance is the cell-site radius; for FTTN or DSL the distance is the maximum loop length.[5] These lengths are typically 1 to 3 miles for twisted pair copper and 2 to 5 miles for wireless towers, and span multiple census blocks. As a result, carriers will make deployment decisions based on larger areas.

From a modeling perspective, evaluation at the census block level is problematic as well. Evaluations of which technology has the lowest investment gap done at the census block level could lead to contiguous census blocks with a patchwork of different technologies that no company would actually build.

Even more problematic is that the cost in any one area is driven in part by the costs of shared infrastructure. For example, the cost of a fiber connecting several new DSLAMs to the local central office is shared among all the census blocks served by those DSLAMs. If wireless were found to be cheaper in one of those census blocks and one, therefore, assumed that one of those DSLAMs would not be deployed, the (allocated) cost of the fiber would increase for all remaining DSLAMs. That could lead to another block where wireless is made cheaper, again increasing the cost of the remaining DSLAMs.

Exhibit 3-C: Incremental Revenue by Product and Network Type

	Data	Voice	Video
Telco 12k	Yes	No	N/A
Telco 5k/3k/FTTP	Yes	No	Yes
Cable[6]	Yes	Yes	Yes
Wireless-Fixed	Yes	Yes	N/A
Wireless-Mobile (Non-4G)	Yes	Yes	N/A
Wireless-Mobile (4G)	No	No	N/A

There is no perfect solution to this problem. If the geography is too big there will be portions that would be more efficiently served by an alternate technology, but if the geography is too small it will be subscale, thereby driving up costs. Although the model is capable of evaluating at any aggregation of census blocks, in order to avoid a patchwork of technologies that are all subscale, we have evaluated the cost of technologies at the county level. Counties appear large enough in most cases to provide the scale benefits but not so large as to inhibit the deployment of the most cost-effective technology.

Note that this geography is also technology neutral since it is not aligned with any network technology's current footprint. No network technology boundaries line up exactly with those of counties. Cable networks are defined by their franchise area; wireless spectrum is auctioned in several different geographies, for example, by cellular market areas; and telco networks operate in study areas, LATAs or wire centers. Since the model is capable of evaluating at any aggregation of census blocks, it is possible to evaluate at more granular levels (where the patchwork problems become more likely) or at more aggregated levels.

Technologies must be commercially deployable to be considered part of the solution set. *Though the economic model is forward looking and technologies continue to evolve, the model only includes technologies that have been shown to be capable of providing carrier-class broadband. While some wireless 4G technologies arguably have not yet met this threshold, successful market tests and public commitments from carriers to their deployment provide some assurance that they will be capable of providing service.*

With the exception of 4G wireless, we only include technologies that are widely deployed and have proven they can deliver broadband. Although network technologies continue to advance, enabling operators to provide more bandwidth over existing infrastructure or to provide new services ever-more-cheaply, the promise surrounding technological innovation often outstrips reality.

To avoid a situation where we assume uncertain, future technological advances are essential to a particular solution—where the solution with the lowest investment gap is reliant on unproven technologies—this analysis focuses on technologies which have been substantially proven in commercial deployments. Over long periods, this may tend to overestimate some costs; however, a significant fraction of deployment costs are insensitive to technology (for example, the cost of trenching) while other costs are technology independent (for example, the cost of a DSLAM chassis would be independent of what type of DSL is being used), meaning that overall impact should be minimal.

One notable exception is our treatment of wireless. Our focus on wireless, whether for fixed or mobile, is on 4G technologies that have only just begun to be deployed commercially. Initial trials and our research with service providers and equipment vendors give us confidence in 4G's ability to provide the stated performance at the stated costs—enough confidence to warrant including 4G in our analysis.[6] In addition, because of the significant advancements of 4G relative to current capabilities and the widespread 4G deployment forecasts, we would run the risk of overstating the Investment Gap significantly if we were to exclude it from our analysis.

As noted in the CITI report[7], a significant fraction of areas served by wireless today are likely to be upgraded to 4G service by wireless operators without external (public) support.

Only one U.S. carrier, Clearwire, has deployed a mobile 4G (WiMAX) network commercially, making it difficult to know how much of the unserved population will be covered by 4G. For our model, we take Verizon's announced build-out as the 4G footprint because Verizon is the only operator that has announced precisely where its 4G builds will take place. Verizon has committed to rolling out 4G to its entire 3G service footprint (including those areas acquired with Alltel). The net result is that we assume 5 million of the 7 million unserved housing units will have access to 4G service (i.e., 5 million housing units are within Verizon Wireless's current 3G footprint, which the company has committed to upgrading to 4G).

No wireless carrier, including Verizon Wireless, has committed to offering service consistent with the National Broadband Availability Target. This uncertainty in the ability of wireless-network deployments to deliver fixed-replacement service points to the need for incremental investment by wireless carriers. Simply put, networks designed for relatively low-bandwidth (typically mobile) applications, potentially lack the cell-site density or network capacity to deliver 4 Mbps downstream, 1 Mbps upstream service.

Our calculations for 4G fixed wireless includes incremental investments sufficient to ensure networks capable of delivery consistent with the National Broadband Availability Target. See the section on wireless in Chapter 4 and the Assumptions discussion later in this chapter for more details.

KEY DECISIONS

Implicit within the $23.5 billion gap are a number of key decisions about how to use the model. These decisions reflect beliefs about the role of government support and the evolution of service in markets that currently lack broadband. In short, these decisions, along with the assumptions that follow, describe how we used the model to create the $23.5 billion base case.

- Fund only one network in each currently unserved geography.
- Capture likely effects of disbursement mechanisms on support levels.
- Focus on terrestrial solutions, but not to the exclusion of satellite-based service.
- Support any technology that meets the network requirements.
- Provide support for networks that deliver proven use cases, not for future-proof buildouts.

Fund only one network in each currently unserved geography. *The focus of this analysis is on areas where not even one network can operate profitably. In order to limit the amount of public funds being provided to private network operators, the base case includes the gap for funding only one network.*

The $23.5 billion Investment Gap is based on the decision, for modeling purposes, that only one network will be funded in each unserved area. The reason for funding only one network is to keep the amount of public money required to a minimum.

Alternative approaches that would fund more than one network per area—for example, funding one wireline and one fixed-wireless network—would increase the total gap significantly for several reasons. First, the gap must include the costs associated with building and operating both networks. Second, because the two providers are competing for the same customers, each will have a lower take rate and, therefore, lower revenue.[8] While this lower revenue will be partially offset by lower variable costs—stemming from savings tied to costs like customer support and CPE—the net effect will be much higher costs per subscriber. For example, having both one wireline and fixed-wireless provider moves the Investment Gap up 45%, from $23.5 billion to $34.2 billion.

Funding two wireline competitors (instead of one wireline and one wireless) in these unserved areas has an even larger impact. Since only the first facilities-based service provider can make use of the existing twisted-pair copper network, the second facilities-based provider must deploy a more expensive, greenfield FTTP network (whether telco based or cable-based RFOG; see Chapter 4 discussion of FTTP and HFC). As shown in Exhibit 3-E, having two wireline providers in unserved areas shifts the investment gap to $87.2 billion.

While funding only one broadband provider in each currently unserved market leads to the lowest gap, this choice may carry costs of a different sort. In areas where a wireless provider receives support to provide both voice and broadband service, the incumbent wireline voice provider may need to be relieved of any carrier-of-last-resort obligations to serve customers in that area. In such a circumstance, it may be that only wireless operators will provide service in these areas. If, at some point in the future, the National Broadband Availability Target is revised in such a way that a wireless carrier can no longer economically provide service, a wireline provider may need to build a new, higher-speed network.

As noted above, competition impacts the take rate for each operator. In addition, we assume that competition leads to lower average revenue per user (ARPU). See Exhibit 3-F.

Exhibit 3-D:
Gap for Funding One Wired and One Wireless Network

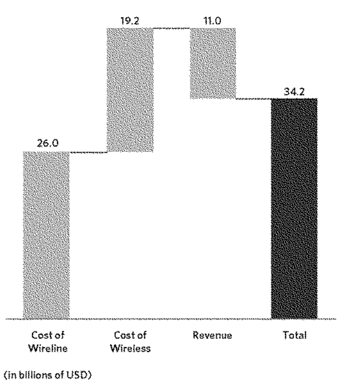
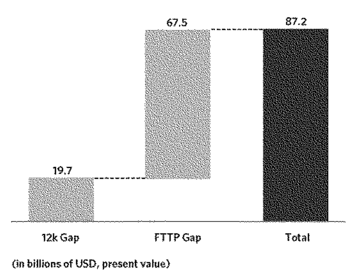


Exhibit 3-E:
The Cost of Funding Two Wired Networks



Since costs are calculated based on demand, reducing take rate will also reduce some costs. In particular, CPE costs are driven directly by the number of competitors. In addition, the cost of some network equipment, including last-mile equipment like DSLAMs, is sized according to the number of customers. This calculation will capture both the reduction in total cost and the increase in cost per user that comes from having fewer customers.

Exhibit 3-G shows the impact of competition on the investment gap for both 12,000-foot FTTN and wireless solutions. Remember that the base-case Investment Gap is calculated from a mix of technologies in markets across the country.[9]

Capture likely effects of disbursement mechanisms on support levels. *Decisions about how to disburse broadband-support funds will affect the size of the gap. Market-based mechanisms, which may help limit the level of government support in competitive markets, may not lead to the lowest possible Investment Gap in areas currently unserved by broadband—areas where it is difficult for even one service provider to operate profitably.*

A mechanism that selects the most profitable (or least unprofitable) technology in each area would minimize the overall size of the NPV gap. In highly competitive markets, market-based mechanisms, including reverse auctions, can play that role.[10] However, in unserved areas, where the economics of providing service are challenging, the impact of market-based mechanisms is less clear.[11]

Since the incremental economics of deploying broadband for each technology depend on the infrastructure that is already deployed, there may only be a single operator capable of profitably deploying a given technology in a given area. In these cases where there are no competing bidders with similar economics, the bidder with the lowest investment gap may not bid based on its economics but rather the economics of the next-lowest-gap technology. In other words, the lowest-gap provider may be in a position to set its bid to be almost as high as the next lowest-gap competitor. Due to this reality, we have calculated the gap based on the second-lowest gap technology, so that we do not grossly underestimate the gap in these areas.

The lowest-gap provider may not always be able to extract the highest level of support because it may have imperfect information about its competitor's economics, or fear that it does. However, we believe calculating the gap based on the second-lowest gap technology is conservative and will be closer to reality in these markets.

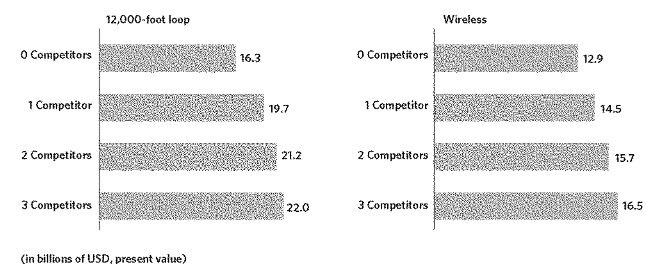
A calculation of the gap, assuming the lowest-cost operator provides service to all currently unserved areas, is $8.0 billion. The gap assuming the second-lowest-cost-gap provider in unserved areas is $23.5 billion. Since wireless appears to be the lowest gap technology in most unserved markets, and there is

Exhibit 3-F: Quantifying the Treatment of Competition

	Reduction in ARPU*	Reduction in Take Rate
0 Competitors	0.0%	0.0%
1 Competitor	4.3%	50.0%
2 Competitors	14.8%	66.7%
3 Competitors	28.2%	75.0%

* average revenue per user

Exhibit 3-G: Quantifying the Impact of Competition: Investment Gap by Number of Providers



a large disparity in cost between the first and second wireline competitor, excluding wireless from the analysis has a disproportionately large effect on the gap. As noted previously, the second wireline competitor in an area will not be able to take advantage of existing last-mile infrastructure and will, therefore, need to deploy a network connection all the way to the home. As such, the second wireline competitor has much higher costs than the first. If wireless is not part of the analysis and the second-lowest-gap provider uses wired technology, the gap moves up to $62 billion.

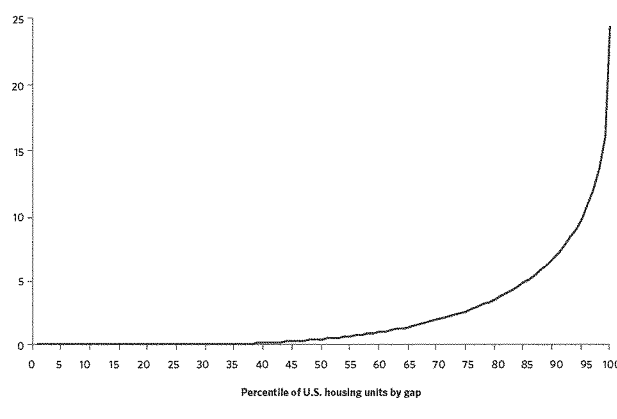
Focus on terrestrial solutions, but not to the exclusion of satellite-based service. *Satellite-based service has some clear advantages relative to terrestrial service for the most remote, highest-gap homes: near-ubiquity in service footprint and a cost structure not influenced by low densities. However, satellite service has limited capacity that may be inadequate to serve all consumers in areas where it is the lowest-cost technology. Uncertainty about the number of unserved who can receive satellite-based broadband, and about the impact of the disbursement mechanisms both on where satellite ultimately provides service and the size of the investment gap, all lead us to not explicitly include satellite in the base-case calculation.*

The $23.5 billion Investment Gap calculation estimates the gap to providing service to all housing units in the country with terrestrial service, either wired or wireless. While it seems likely that satellite will be an important part of the solution to the problem of serving the high-cost unserved, the current analysis includes only terrestrial solutions. Satellite has the advantage of being both ubiquitous and having a cost structure that does not vary with geography, making it particularly well suited to serve high-cost, low-density areas. Nevertheless, the focus of the model analysis remains on terrestrial providers.

While satellite is nearly universally available and can serve any given household, satellite capacity does not appear sufficient to serve every unserved household. In addition, the exact role of satellite-based broadband, and its ultimate impact on the total cost of universalizing access to broadband, depends on the specific disbursement mechanism used to close the broadband gap. The optimal role could be in serving housing units that have the highest per-home gap, or in ensuring that satellite can function as a ubiquitous bidder in a range of auctions. Moreover, while satellite firms can increase their capacity through incremental launches—noting that the current analysis includes all known future launches—the timing for bringing this capacity on-line may be problematic for closing the broadband gap, given the time required to design, build and launch a new satellite.

As noted in Exhibit 1-C, the most expensive counties have a disproportionately large investment gap. That same pattern—the most expensive areas drive a very high fraction of the gap—is repeated at smaller and smaller geographies. Exhibit 3-H shows the gap for all the unserved. The most expensive

Exhibit 3-H. Broadband Investment Gap, by Percent of Unserved Housing Units Served



3.5% of the unserved (250,000 housing units, representing < 0.2% of all U.S. housing units) account for 57% or $13.4 billion of the total gap. Were that group served by, for example, satellite broadband, even with a potential buy-down of retail prices, the gap could be reduced to $10.1 billion.[12]

Increasing the number of homes not served by terrestrial broadband leads to diminishing benefit, however. Moving the most expensive 15% of the unserved off of terrestrial options yields a gap of $3.8 billion. In other words, the savings from moving the first 3.5% off of terrestrial options ($13.4 billion) is more than twice the savings from moving the next roughly 12%.[13]

Support any technology that meets the network requirements. *Broadband technologies are evolving rapidly, and where service providers are able to operate networks profitably, the market determines which technologies "win." Given that, there appears to be little-to-no benefit to pick technology winners and losers in areas that currently lack broadband. Therefore, the base case includes any technology capable of providing service that meets the National Broadband Availability Target to a significant fraction of the unserved.*

The purpose of the Investment Gap calculation is not to pick technology winners and losers, but to calculate the minimum gap between likely private investment and the amount required for universal broadband. Therefore, the model is designed to calculate the profitability of multiple technologies to understand the cost and profitability of each.

The focus on profitability—on minimizing an area's investment gap—will lead to calculating the gap based on the least unprofitable mix of technologies. However, this is not an endorsement of any technology over another, or a recommendation for serving demand in any given area with a specific technology.

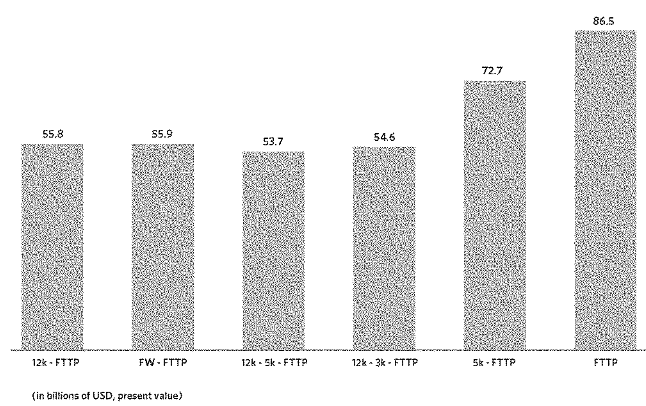
Over time, it may be the case that several technologies' capabilities improve, or their costs fall, more quickly than has been calculated—in which case, multiple competing technologies could profitably serve demand with a subsidy smaller than the one we calculate. Also, individual providers may have, or believe they have, the ability to provide service more cheaply.

Ultimately, the model assumes that any technology that meets the National Broadband Availability Target will be eligible to provide service.

Provide support for networks that deliver proven use cases, not for future-proof buildouts. *While end-users are likely to demand more speed over time, the evolution of that demand is uncertain. Given current trends, building a future-proof network immediately is likely more expensive than paying for future upgrades.*

The calculation of the $23.5 billion Investment Gap is focused on ensuring universal delivery of broadband over the next decade. However, given historical growth rates, it may eventually be the case that networks designed to deliver 4 Mbps downstream/1 Mbps upstream will be incapable of meeting future demand. In such a case, additional investments

Exhibit 3-I:
Total Investment Cost for Various Upgrade Paths



beyond those included in the $23.5 billion gap calculation might be required. Whether historical growth rates continue is dependent on a variety of factors that cannot be predicted. If, however, we make assumptions about growth over time, we can estimate the impact on deployment economics.[14]

For example, the growth rate in the speed of broadband in recent years of approximately 20% suggests that broadband networks might be called upon to deliver speeds higher than 4 Mbps (downstream) and 1 Mbps (upstream) across the next decade or more. Simply put: if required speeds continue to double roughly every three years, demand will outstrip the capabilities of 4G and 12,000-foot-loop DSL.

To account for the current investments as well as these potential future investments, we calculated the lifetime cost of different technology upgrade paths. We evaluate the cost of deploying different technologies including the cost of future upgrades driven by the evolution in network demand, discounted to today. Although the lowest lifetime-cost technology will differ by market, it is possible to calculate the costs associated with various upgrade paths for the unserved areas as a whole, as shown in Exhibit 3-I.

To calculate the total cost for potential upgrade paths, a number of assumptions are necessary. The most important assumptions are the growth rate in broadband speed and the amount of salvage value remaining in a network when it is upgraded. For this calculation, the broadband speed is set to 1 Mbps (downstream) in 2010 and is grown at a rate of approximately 26% per year. When a network is upgraded, the capex required for the upgrade is reduced by the salvage value of the existing network – an upgrade that makes use of many of the assets of the original build will be cheaper. For example, fiber runs used to shorten loops to 12,000 feet will defray the cost of further loop shortening.

In this lifetime-cost calculation, an initial FTTP build-out is the most expensive because none of the initial capex is discounted. Regardless of which path is chosen, deferring the FTTP build-out lessens the total cost burden due to the time value of money. A number of the wireline upgrade paths have similar results. Again, the main differences between these options are salvage value and time value of money, given the assumed broadband growth rate.

This approach disadvantages fixed wireless relative to the other technology paths. Since the calculation only takes into account the ability to provide fixed broadband service, when the requirements for bandwidth outstrip the wireless networks' capability to provide economical fixed service, this calculation assumes that there is no value in wireless networks once they are overbuilt. In reality, and not captured in the calculation, wireless networks would have substantial salvage value in providing mobile service; i.e., once wireless networks can no longer meet the demands of fixed broadband, they can continue to generate value by delivering mobile services. This is in contrast to investments made in second-mile FTTN fiber that reduce the costs of future FTTP buildouts. However, despite this disadvantage, the fixed-wireless-to-FTTP upgrade path has the same total cost as the 12-kft-DSL-to-FTTP upgrade. Fixed wireless has lower initial capex; this lower capex offsets both higher opex for the wireless network and the cost savings from re-using fiber deployments made for a 12,000-foot-loop deployment. See, for example, Exhibits 4-W and 4-AK.

Note that this calculation is very sensitive to the growth rate assumed in required service speeds. If demand for speed grows only at 15% annually, the cost of the second upgrade path (fixed wireless upgraded to FTTP) drops by 23% as future upgrades are pushed out into the future and discounted further; these cost savings are partially offset by the higher opex of the fixed wireless network remaining in operation for more years. The cost of the first upgrade path (12,000-foot-loops upgraded to FTTP) drops even more, by 26%, as the FTTP investment is delayed.

KEY ASSUMPTIONS

Also implicit in the $23.5 billion gap are a number of major assumptions. In some sense, every input for the costs of network hardware or for the lifetime of each piece of electronics is an assumption that can drive the size of the Investment Gap. The focus here is on those select assumptions that may have a disproportionately large impact on the gap or may be particularly controversial. By their nature, assumptions are subject to disagreement; the section includes an estimate of the impact on the gap for different assumptions in each case.

- Broadband service requires 4 Mbps downstream and 1 Mbps upstream access-network service.
- The take rate for broadband in unserved areas will be comparable to the take rate in served areas with similar demographics.
- The average revenue per product or bundle will evolve slowly over time.
- In wireless networks, propagation loss due to terrain is a major driver of cost that can be estimated by choosing appropriate cell sizes for different types of terrain and different frequency bands.
- The cost of providing fixed wireless broadband service is directly proportional to the fraction of traffic on the wireless network from fixed service.
- Disbursements will be taxed as regular income just as current USF disbursements are taxed.
- Large service providers' current operating expenses provide a proxy for the operating expenses associated with providing broadband service in currently unserved areas.

Assumption: Broadband service requires 4 Mbps downstream and 1 Mbps upstream access-network service.[15]

This analysis takes the speed requirements of the National Broadband Availability Target as a given. That is to say that while there are ample analyses to support the target,[16] for the purposes of this analysis the required speed is an input. Below are some brief highlights from the research about speeds available and the impact of different assumptions about speed on the size of the financial gap.

Briefly, there are two independent but complementary approaches to setting the speed target for this analysis. The first approach examines the typical (median) user's actual speed delivered. As shown in Exhibit 3-J, median users receive 3.1 Mbps. In other words, half of all broadband subscribers currently receive less than 3.1 Mbps. These data are from the first half of 2009; based on growth rates (as described elsewhere), the median will likely be higher than 4 Mbps by end of 2010. Updated data from a smaller sample show a median of 3.6 Mbps in January of 2010.

The second approach is to examine the use of applications by end-users to determine what level of broadband speed is required to support that level of use. Typical usage patterns today correspond to the "emerging multimedia" tier shown in Exhibit 3-K, with a growing portion of subscribers being represented best by the "full media" tier. Advanced Telecommunications Capability, including high-speed video, would seem to require at least the 4 Mbps "full media" tier.

While this suggests that speeds as low as 1 Mbps might be sufficient, it is worth noting that demand for broadband speeds has grown quickly, as shown in Exhibit 3-L. In fact, broadband speeds have grown approximately 20% annually since 1997.

Taken together, the median actual speed subscribed (3.1 Mbps, approaching 4 Mbps by year end) and the applications usage (1 Mbps but doubling every three-to-four years) suggest that a download speed of 4 Mbps will provide an adequate target with headroom for growth for universalizing purposes. Although not "future proof," this headroom provides some protection against rapid obsolescence of a high sunk-cost investment.

The calculations in this document focus on the National Broadband Availability Target. However, we built the tool with sufficient flexibility to calculate the gap across a range of target performance levels.

For example, if consumers demand only 1.5 Mbps, fewer housing units would be considered unserved (i.e., those with service above 1.5 Mbps but below 4 Mbps would be considered to have service). In addition, at the lower speed a lower-cost technology, DSL with 15,000 foot loops, becomes viable.

Should consumers demand higher speeds, in contrast, more people would be considered unserved. At the same time, only technologies capable of delivering higher speeds will be part of the solution set (e.g., 3,000-or 5,000-foot-loop FTTN, or FTTP).[17] See Exhibit 3-M.

Exhibit 3-J: Distribution of Users by Actual Maximum Download Speeds (Mbps)[18]

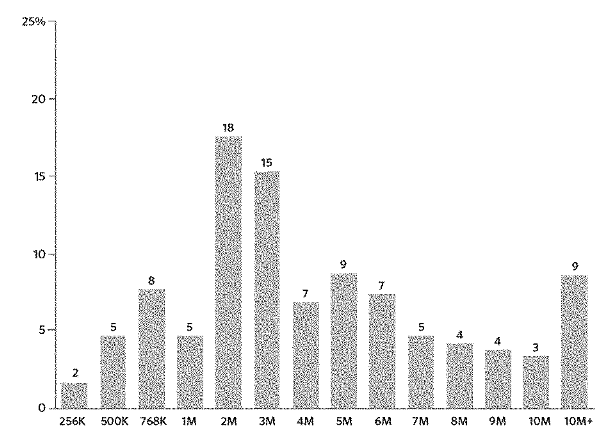


Exhibit 3-K:
Actual Download Speeds Necessary to Run Concurrent Applications (Mbps)

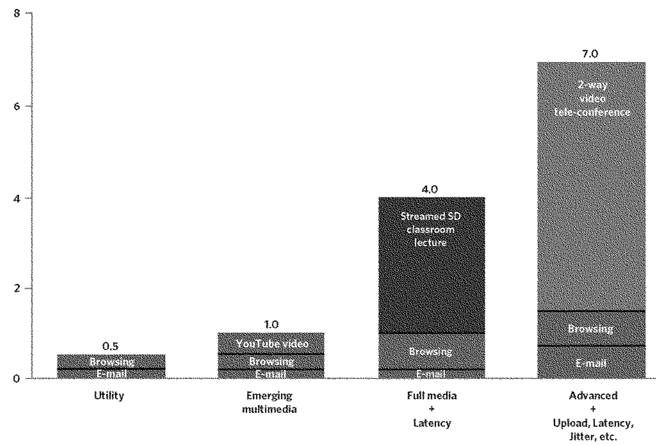
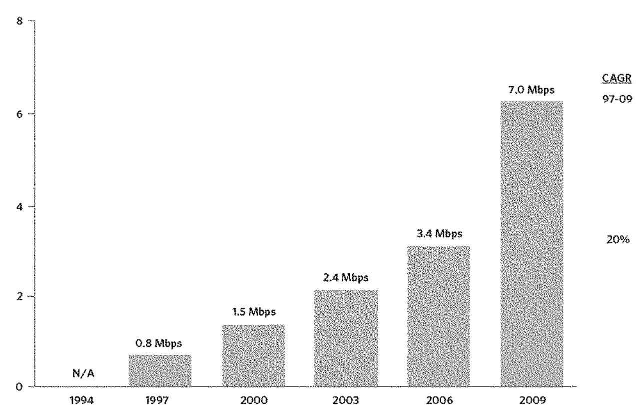


Exhibit 3-L:
Typical (Median) "Up To" Advertised Download Speeds of Most Commonly Deployed and Chosen Consumer Household Broadband (Mbps)



Assumption: The take rate for broadband in unserved areas will be comparable to the take rate in served areas with similar demographics.

We need a measure of adoption over time to understand how quickly operators would attract customers—and accordingly revenue—to offset costs. Moreover, to be consistent with the granularity we have built into the model, it is necessary to make adoption sensitive to demographics.

In order to determine penetration rates of new broadband deployments in unserved areas, we choose to perform a combination of several statistical and regression analyses. Our primary data source is a table of home broadband adoption metrics from the Pew Internet & American Life Project. Since 2001, the Pew Research Center has conducted extensive, anonymous phone surveys on broadband adoption in the United States, breaking out responses by various demographics. Its surveys reveal positive and negative correlation factors between certain demographic characteristics and broadband adoption.[19] The Pew study noted the most significant factors, which are shown in Exhibit 3-N, in order of importance.

We obtained the results of the Pew study on broadband adoption covering 19 survey periods from October 2001 to November 2009. These data aggregate adoption percentages in each period by race, income, education level, rural/non-rural and overall.

Preliminary findings of the data revealed that the trends in broadband adoption matched those of standard technology adoption lifecycles. Our approach to this analysis is to understand the shape and characteristics of the Pew adoption curves in an attempt to incorporate the results into a mathematical model, by which future broadband adoption, or adoption in currently unserved areas, could then be forecast. We begin by examining a popular mathematical model used to forecast technology adoption: the Gompertz model.[20] Exhibit 3-O explains the highlights of the Gompertz model.

Exhibit 3-P illustrates the cumulative characteristics of the Gompertz model as a percentage of the installed base:

From an *incremental* standpoint, the period-to-period technology adoption unfolds as shown in 3-Q.

Note the characteristic "inflection point"—that is, the point at which the incremental curve is maximized and the cumulative curve flips over.[21] The inflection point should be considered the point where technology adoption reaches its maximum growth rate.

Our analysis of the Pew data consists of fitting each demographic data breakout (overall, race, income, age, education Level, rural/non-rural) into a Gompertz curve using a least

Exhibit 3-M: Dependence of the Broadband Investment Gap on Speed of Broadband Considered[22]

Broadband Speed (downstream)	Number of unserved HUs (millions)	Technology	Total cost ($ billions)	Investment gap per technology ($ billions)
1.5 Mbps	6.3	15,000-foot DSL	21.9	15.3
4 Mbps (base-case)	7.0	12,000-foot DSL	26.2	18.6
		4G wireless	18.3	12.9
6 Mbps	7.1	5,000-foot DSL	62.8	43.4
		3,000-foot DSL	76.9	57.3
50 Mbps	13.7	HFC/RFoG	124.9	85.0
100 Mbps[23]	130.0	FTTP	669.6	321.8

Exhibit 3-N: Broadband Take-Rate Drivers

Positively Correlated	Negatively Correlated
Income greater than $100K	Less than high school education
Income between $75K-$100K	Senior citizen (65+)
College degree or greater eduction	Rural
	High school degree only

Exhibit 3-O:
Model for Technology Adoption

Model	Equation	When Used	Examples
Gompertz	$y=e^{-e^{-b(t-a)}}$	When substitution is driven by superior technology, but purchase depends on consumer choice.	Digital television, mobile phones

Exhibit 3-P:
Modeled Cumulative Adoption

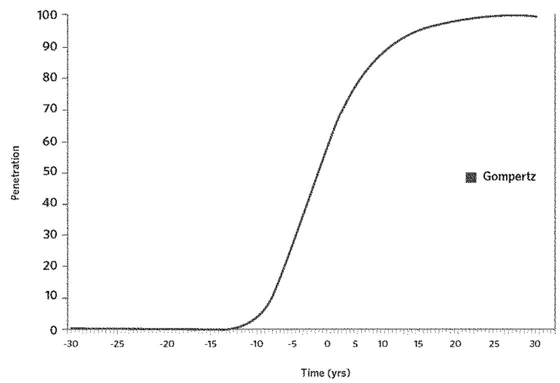
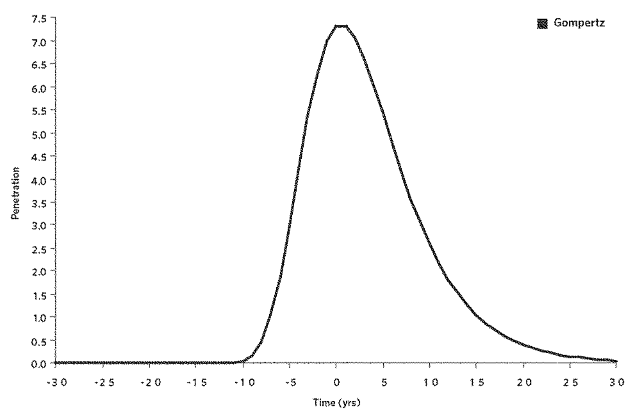


Exhibit 3-Q:
Incremental Adoption



squares approach.[24] With a semiannual time period adjustment, the results indicated the Pew data segments can be fit on a corresponding Gompertz cumulative curve with very reasonable least squares accuracy. One such curve fit for a particular demographic (college graduates) is shown in Exhibit 3-R.

Our analysis provides us with Gompertz curves by each demographic in the Pew survey. However, consider that the Pew research starts with an arbitrary date of October 2001. This date does not presume the "start" of broadband in each surveyed area; it only represents the date at which surveys began. Therefore we must provide a time-based adjustment for every demographic curve. The solution we determine as most appropriate is to develop a series of demographic adoption curves relative to the overall adoption curve. Exhibit 3-S illustrates the relative Gompertz curve fits for every demographic segment. Here, the overall adoption curve inflects at zero on an adjusted time scale.[25]

Reinforcing the conclusions of the Pew study, the Income over $75K and College or Greater Education curves are farthest to the left (representing more rapid adoption relative to the mean), while the High School or Less, Rural and 65+ curves are farthest to the right (representing slower adoption relative to the mean).

It is worth noting that the Gompertz curves are based on adoption in areas across time, largely when broadband was first introduced—i.e., in greenfield areas. In brownfield deployments, however, builders are leveraging previous deployments to capture consumers who have already been educated on the benefits of broadband. We therefore allow for an additional time adjustment where brownfield builds are taking place.

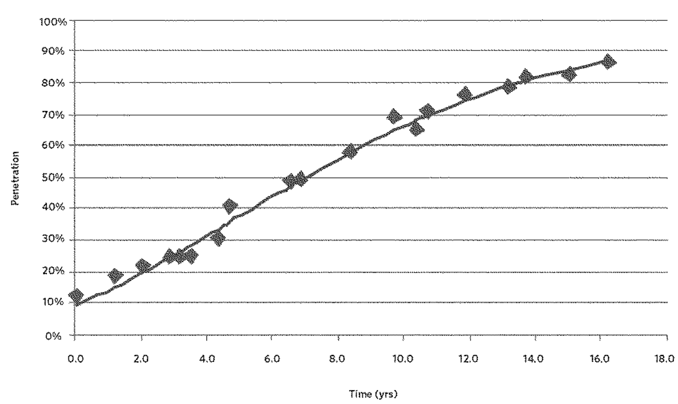
These results provide relative Gompertz curves by every demographic measured in the Pew study; however for a number of reasons, we chose to limit the prediction model to only the demographic factors with the largest positive and negative correlation to broadband adoption. While it would technically be possible to measure adoption changes across all the available demographics on the Pew study, it does not improve results meaningfully to do so—either the remaining demographics had minimal influence on broadband adoption, or the demographic data in question were not readily available at the appropriate demographic level.

The demographic variables we chose to predict broadband adoption are the following:

- Income greater than $100K
- Income between $75K – $100K
- College degree or greater education
- Senior citizen (65+)
- Less than high school education
- Rural
- High school degree only

Using the Gompertz coefficients for each demographic, combined with demographic data at the census block level,[26] we can build Gompertz curves for every census block in the nation. To build these custom curves, we weight the demographic Gompertz

Exhibit 3-R: Broadband Adoption Curve



coefficients (a and b) by the incremental demographics prevalent in the area. For example, if the demographics within the overall curve show 18.5% of households have incomes above $100K, but a particular census block contains 20% of households with over $100K income, each "Over $100K" Gompertz coefficient would be weighted by the incremental difference (20% – 18.5% = 1.5%) and added to the overall Gompertz coefficient. By summing up the weightings off each significant variable, our Gompertz equation for each census block would take shape.

The additional step in forecasting broadband penetration rate is to determine how to factor in a brownfield effect, if any, into the census block time coefficient (a). If the census block is revealed to have a prior broadband deployment, the census block curve would be shifted left a designated number of periods. The number of periods to shift is held constant across all brownfield deployments.

The final step of developing the census block curve is to determine where to set the inflection point. The zero point on the horizontal axis scale is intended to represent the point at which the overall curve inflects, but the time at which the scale hits zero must be determined. We initially chose this scale to be two years from the start of deployment; essentially, the overall broadband adoption would reach its maximum growth rate in 24 months. To account for the initial mass influx of customers in the first 24 months, we chose to start with zero subscribers at initial deployment, then trend towards the number of subscribers at 24 months by dividing them into four equal 6-month periods of subscriber adoption. After 24 months, the penetration rates reflected in the Gompertz curve would be in effect. The selection of an inflection point, while initially set at 24 months, is one that can potentially be re-examined and adjusted as needed.

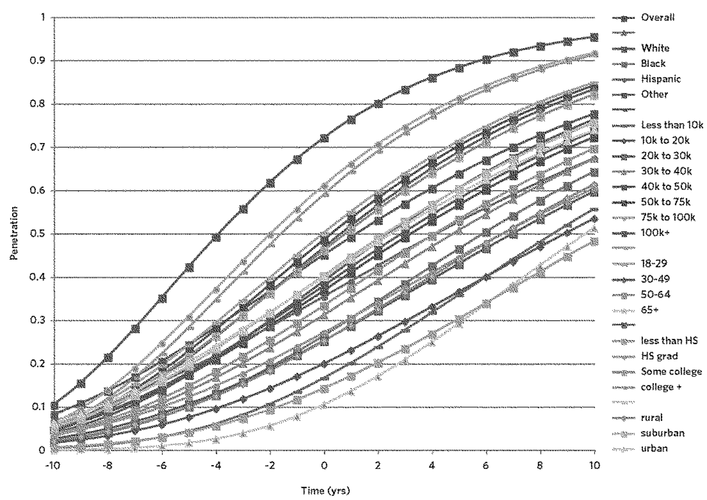
Additional factors

The resulting census block penetration rate determines the standard broadband adoption rate for that census block. It does not, however, factor in the subscribers of related incremental services (e.g., voice, video), the effect of bundled services or the stratification of tiering (basic vs. premium). To account for each of these, we developed factors from which we could adjust the baseline number of expected broadband adopters in every census block. Each factor is discussed below.

Scaling factor

A scaling factor, in this instance, refers to a multiplying factor developed to predict voice and video subscribers by technology (DOCSIS, FTTP, FTTN and Fixed Wireless) based on the number of broadband subscribers.[27] The presumption is that

Exhibit 3-S: Gompertz Curves for Broadband Take Rate With Demographics



each technology exhibits a constant and unique relationship between broadband subscribers and subscribers to other services like voice and video. In other words, if one knows the number of broadband subscribers for a particular technology, one can predict the number of voice or video subscribers as well.

Bundling percentages

Customers who subscribe to broadband services belong to one of two groups: those that purchase a la carte, or those that purchase as a bundle. Industry analysis confirmed that the relationship between the two subscriber bases is relatively constant for each technology.[28] Using these data, we developed a "bundling" percentage based on the broadband subscribers, in order to arrive at the number of bundled subscribers. The number of bundled customers can then be subtracted from the total number of voice and video subscribers to arrive at the number of a la carte subscribers for each. The percent of users who take bundles for each technology is shown in Exhibit 3-T.

Tiering percentages

Tiering, in this case, refers to the tiered services offered by carriers. To limit unneeded complexity, we limit the number of tiers in the model to two levels: a basic introductory level of service and a "top-shelf" premium service. These low/high tiers are applicable to video (for example, basic vs. premium cable), data (entry-level vs. top speed) and even bundles. Using industry data we are able to develop percentages by technology that break out the respective service subscribers into low-end and high-end tiers.[29] These "tiering" percentages are then applied to the number of broadband, video and bundled subscribers to arrive at low-tier subscribers and high-tier subscribers for each.

Take-rate sensitivities

The Gompertz curve for data product penetration is driven by the demographics at the census block group level and is independent of changes in price. Treating broadband data products as relatively demand inelastic is consistent with the recent findings by Dutz et al (2009), who estimated own-price elasticity for broadband in 2008 to be -0.69.[30] Despite these findings, it is important to understand the impact of adjusting the market penetration levels up and down to show the sensitivity of take rate on costs and revenues. Exhibit 3-U illustrates the impact on the overall private investment gap at different market penetration levels. Note that the bulk of the difference in the gap comes from changes in revenues rather than changes in costs.

Exhibit 3-T:
Assumed Percentage of Customers with Bundles

Data	Percent with Bundles
FTTN	65% (data, voice and video where appropriate)
Wireless	98% (data and voice)
Cable	40% (data, voice and video)
FTTP	67% (data, voice and video)

Assumption: The average revenue per product or bundle will evolve slowly over time.

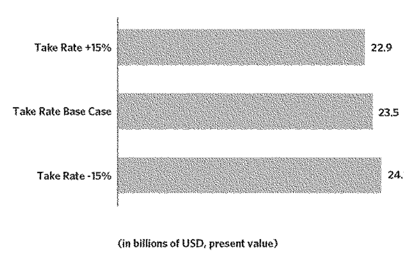
ARPU forecast

In order to develop a close approximation for ARPU, two main issues must be resolved. First, each product category (data, voice, and video) must have an individual ARPU value and the product bundle must also have an ARPU value. An additional level of sophistication, customer segmentation, is added by including a low and high version of the data, voice, video, and bundle product categories. Second, the current disparity in pricing between telco and cable voice products must be resolved.

The complexities of the market create additional challenges. Using estimates of current revenue streams may overestimate, perhaps significantly, the revenue available in the future. Both voice ARPU and the number of residential lines are under pressure from a confluence of technical evolution and new competitive models.[31]

In real terms, the average price of a residential access line has fallen since 1940 by about 50%.[32] Simultaneously, interstate and international per minute revenues have

Exhibit 3-U:
Sensitivity of Gap to Take Rate



dropped steadily since 1985, even in nominal dollars.[33] These trends are the result of competition from wireless and cable, capacity expansion and the advent of Voice-over-IP (VoIP). As these drivers (especially VoIP growth) accelerate, voice ARPU is expected to continue to decline. To account for this market price shift, revenue attributed to incremental voice customers for telcos is set equal to the ARPU for a similar cable VOIP product.

Video ARPU may also be challenged in the years to come. The FCC's cable pricing survey indicates video ARPU has increased year-over-year since 1995 with 55-60% of that increase attributable to programming cost.[34] Cable's video business was protected from competitive threats for much of this historical period, which may change with the recent rise of telco, satellite and "over-the-top" (OTT) or Internet video offerings like Hulu and Netflix. Just as wireline telephone revenues and margins began to shrink after Congress mandated competition in the local telephone market in 1996, it is possible that video ARPU will come under pressure going forward.

Despite these downward trends in per-product ARPUs, annual spending on voice and video services has remained nearly constant as a percentage of total household spending. The annual Consumer Expenditure Survey by the Bureau of Labor Statistics and the FCC's Cable Industry Prices report shows that aggregate annual household expenditure for telephone (wired and wireless) and video has remained between 3.0% and 3.4% of total expenditures between 1995 and 2007.[35]

It is unclear how these trends will play out over time and whether a rise in data-services ARPU will offset expected erosion in voice and video ARPU. The ARPU assumptions in the model are based on a moderate view, where ARPUs evolve slowly over time. Model ARPUs are shown in Exhibit 3-V; note that these ARPUs are the levelized figures across the study time period.

Finally, a number of products either do not yet exist or do not have a long pricing history (e.g. fixed wireless LTE data services). While the average price per minute for a mobile voice call continues to fall or be replaced by unlimited plans, industry forecasts show continued growth in mobile data revenue. As more and more consumers begin using mobile devices as broadband connections, the pricing dynamic between voice and data may shift. While this shift may take place, ultimately we believe the total ARPU per customer as noted above will remain relatively flat.

Drawing on the data and forecast methodology described above, we assume the ARPUs described in Exhibit 3-V.

ARPU sensitivity

Given the product dynamics and uncertainty around the evolution of ARPU in the future discussed above, we conducted a number of sensitivities for overall revenue to estimate the impact of a change in ARPU on the investment gap. Exhibit 3-W shows the change in the amount of support required when the ARPU is scaled up and down by a number of percentages.

Assumption: In wireless networks, propagation loss due to terrain is a major driver of cost that can be estimated by choosing appropriate cell sizes for different types of terrain and different frequency bands.

The cost of wireless deployment varies greatly based on terrain due to reduced propagation in areas with significant elevation change. Simply put: more mountainous areas are harder and more expensive to serve, a fact reflected in the existing wireless coverage of mountainous areas.

General principles for the design of a wireless network (discussed further in the wireless section of Chapter 4) can be used to calculate cell size in areas without geographic interference for a given frequency and required bandwidth. Determining the actual cost of a wireless deployment would require a tuned propagation model.[36] We take an approach somewhere between applying the general principles of wireless network design and a tuned propagation model to take into account the impact of terrain on cell sizes and therefore costs.

To try to capture some of these terrain dependencies, the model adjusts the cell size based on the ruggedness of the terrain. Flat areas are assigned larger cell radii, and therefore lower costs, while hilly and mountainous areas have smaller cell radii and higher costs.

Exhibit 3-V: Summary of Modeled ARPUs

		Data		Video		Bundle	
	Voice	Low	High	Low	High	Low	High
Telco	33.46	36.00	44.00	50.00	80.00	95.57	130.00
Cable	33.46	36.00	44.00	50.00	80.00	95.57	130.00
Wireless (4G footprint)	33.46	36.00	36.00	-	-	56.00	56.00
Wireless (non-4G footprint)	51.96	43.00	43.00	-	-	80.00	80.00

We are able to take into account the different costs across a variety of terrains by first calculating the cost associated with serving each populated census block in the country with two-, three-, five- and eight-mile cell radii—in other words, the total cost of a nationwide network build is calculated for each cell radius, with costs allocated down to census blocks. Census blocks are then aggregated into census tracts.

We then calculate the standard deviation of elevation in each census tract. See Exhibit 3-X to see the variation of elevation across the country.

Areas with high standard deviations have large elevation variability and require smaller two-mile cell sizes; flatter areas have lower standard deviations and are assigned larger cell sizes. See Exhibit 3-Y, which shows cell-size overlaid on the terrain map. The areas with largest cell sizes, indicated in dark blue, are primarily along the coasts and the Mississippi plain. Smaller cell sizes, in green and yellow, are in mountainous areas of the East (along the Appalachians and Berkshires) and in the West.

More detail about cell radii and the impact of wireless model assumptions can be found below in the section on wireless technology.

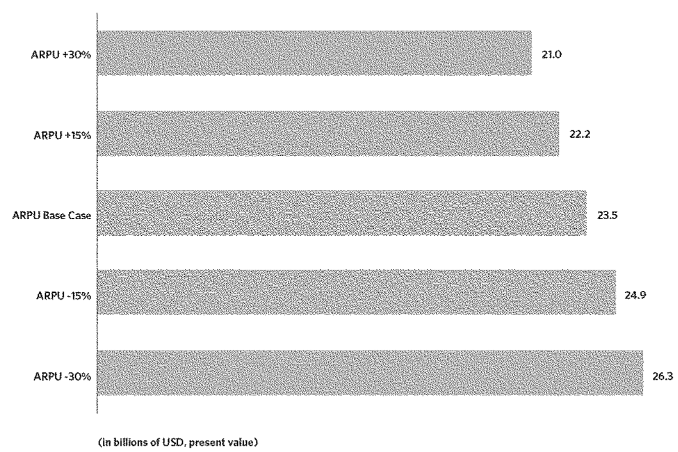
Exhibit 3-Z illustrates the results of making different assumptions about what cell sizes are appropriate in what kinds of terrain. The graph includes the cost of the wireless build; the gap associated with that build; and the overall gap, which because it is driven by the second-lowest-cost technology, varies by less than 10%. In fact, we find that the percentage of unserved housing units served by wireless drops very little (to 89.1% from 89.9% in the most extreme case tested), thus explaining the relatively small impact terrain classification has on the overall investment gap. The analysis and assumptions that led to Exhibit 3-Z are discussed more fully in Chapter 4 (leading up to Exhibit 4-Y).

Assumption: The cost of providing fixed wireless broadband service is directly proportional to the fraction of traffic on the wireless network from fixed service.

The presence of commercial wireless 4G buildouts in areas unserved by terrestrial broadband today can have a major impact on cost and the investment gap. Such commercial buildouts are driven by each company's strategic plans, meaning that the builds could be profitable on their own (i.e., that mobile revenue tied to that location exceeds the cost of deployment), or could be important for other reasons (e.g., to differentiate based on network coverage or to reduce dependence on roaming partners).

Regardless of why such networks are built, their presence has a dramatic impact on local wireless-network economics, since the costs of providing fixed-broadband service will be lower for a service provider that already operates a network that provides mobile services. At issue is the fraction of the total cost required to upgrade commercial buildouts designed

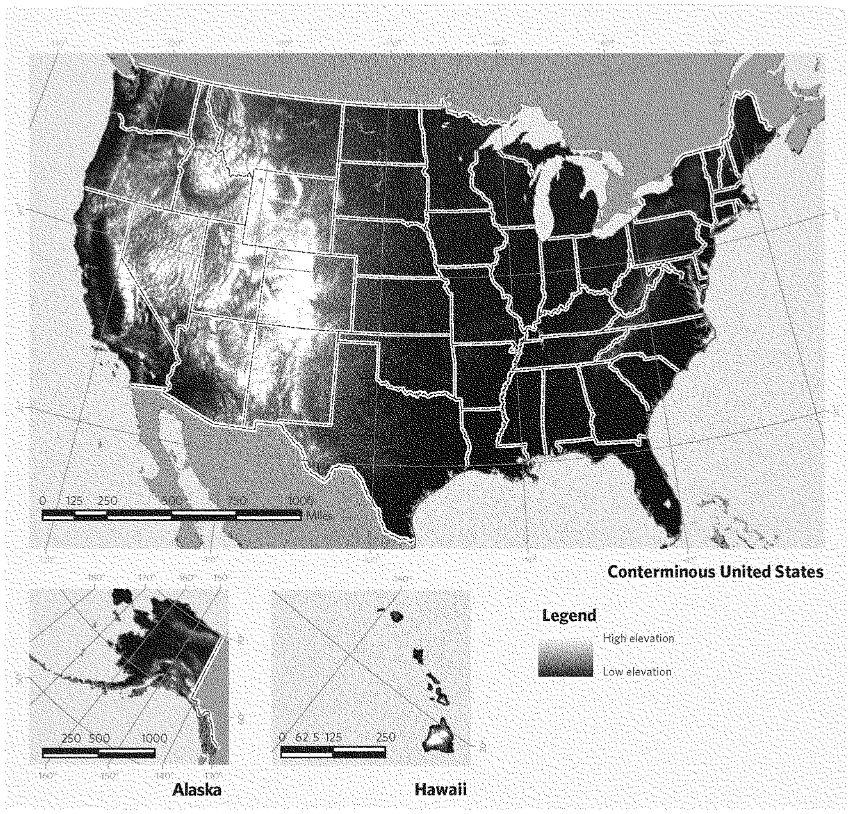
Exhibit 3-W:
ARPU Sensitivity



to provide 4G mobile service to the signal density required to provide fixed service at 4 Mbps downstream/1 Mbps upstream. In addition, the operator would have some amount of revenue even without the fixed-network upgrade. Consequently, we estimated both incremental cost and revenue.

To estimate incremental costs, we allocate costs between the fixed and mobile businesses. While both fixed and mobile businesses benefit from improvements to their shared infrastructure, the fixed business drives many of the costs. Fixed service drives more traffic per connection and, as will be

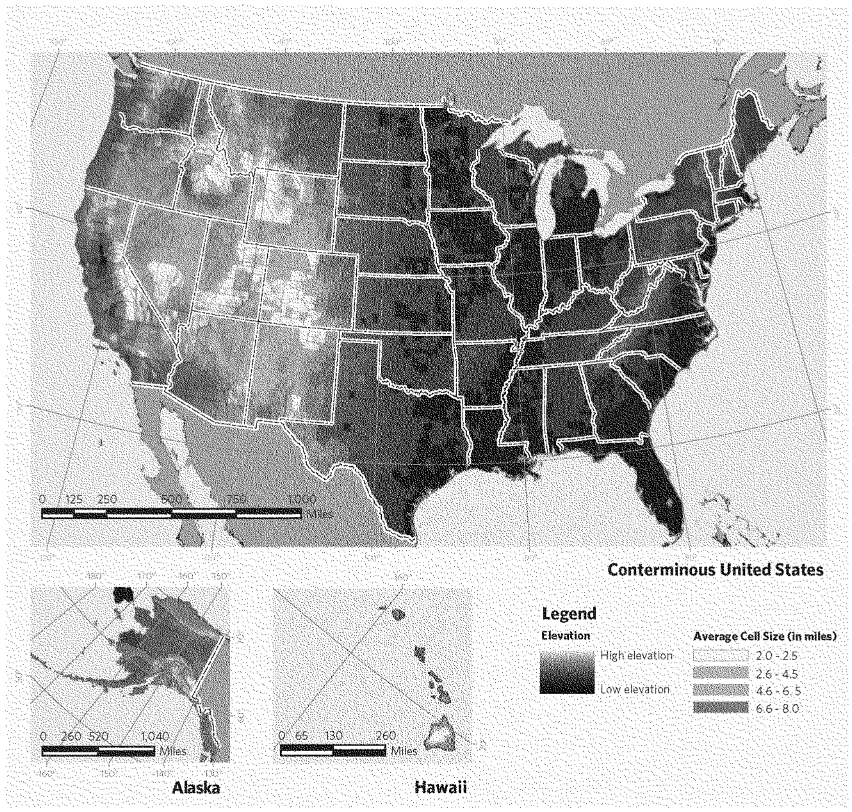
Exhibit 3-X:
Elevation Across the U.S.



discussed later in the wireless portion of Chapter 4, network requirements for fixed broadband service lead to the need for more and smaller cells.

Therefore, the model allocates costs by the amount of traffic driven by fixed and mobile service. The average mobile user with a broadband handset used 65 MB[37] of capacity per month in 2009, while the average fixed user consumed 9.2 GB;[38] however, mobile data usage per user is currently growing at 84%,[39] while fixed usage per user is growing at "only" about 30%.[40] Assuming that there are two mobile users for every fixed

Exhibit 3-Y:
Estimated Average Cell Size in Each County and Terrain



user,[41] and that growth in mobile bandwidth slows to match the growth rate in fixed after five years, fixed service will account for 73% of traffic across the modeled period. Based on these assumptions for traffic allocation, the model allocates 73% of cost to fixed traffic. In other words, the model assumes that mobile carriers can allocate 27% of the build out and operations cost to mobile products, reducing the cost of providing fixed service. If the costs were evenly divided such that 50% of the cost is allocated to fixed and 50% to mobile, the Investment Gap for wireless would decrease to $10.8 billion. If 100% of the cost were allocated to fixed, the Investment Gap for wireless would increase to $15.8 billion.

Offsetting these cost savings is the fact that existing operators may not have significant incremental mobile revenue. The assumption in the model is that there is no incremental mobile revenue within the assumed 4G footprints as defined above (i.e., the carrier does not gain new mobile revenue by building out a network capable of providing 4/1 Mbps fixed service). In other words, the model (conservatively) assumes that a wireless carrier will not increase its share of mobile revenue by adding fixed service.

Outside the assumed 4G footprint, there is no allocation issue: all revenue (fixed and mobile) and all costs are incremental in these areas. The model calculations, therefore, include both fixed and mobile revenue, and 100% of the cost of building and operating the network in those areas outside the 4G footprint.

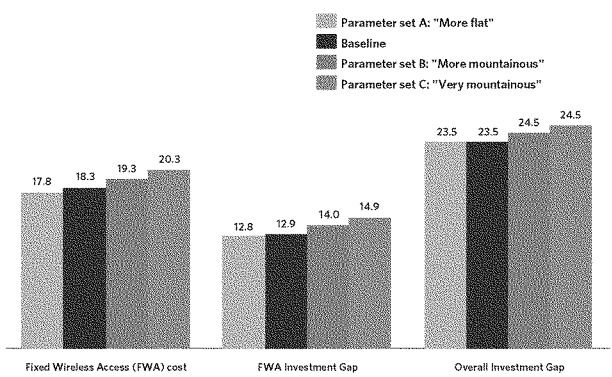
If one does not allocate some fraction of cost to mobile traffic—if, in other words, one requires the fixed network to provide returns without the benefit of mobile revenue—the Investment Gap for wireless grows to $16.5 billion. On the other hand, the overall Investment Gap, which is set by the second-least-expensive technology, moves very little, to $25.6 billion.

A new entrant would not have the same starting point. All revenue and all cost would be incremental for a new operator. However, within the 4G footprint, a new operator would face competition in both fixed and mobile markets—and would, therefore, have lower take rate and/or ARPU (as noted above).

Outside the 4G footprint, the Investment Gap calculation is relatively straightforward. Whoever provides broadband service will need to assume all deployment costs and will benefit from both fixed and mobile revenues—though carriers are likely to face some amount of (at least 2G) competition for mobile revenue.[42] Inside the 4G footprint, the gap calculation is more complex. For a major wireless company, likely to build out some amount of 4G commercially, the calculation needs to focus on incremental revenue—revenue for fixed service;[43] and incremental cost—the cost for upgrading to offer 4 Mbps downstream, 1 Mbps upstream service.

Assumption: Disbursements will be taxed as regular income just as current USF disbursements are taxed.
Generally, gross income means all income from whatever source derived.[44] Therefore, taxpayers other than nonprofit or governmental entities must include governmental grants in gross income absent a specific exclusion. In certain circumstances, governmental grants to a corporation[45] may qualify for

Exhibit 3-Z: Sensitivity of Build-Out Cost and Investment Gap to Terrain Classification Parameters[46]



(in billions of USD, present value)

exclusion from gross income as a non-shareholder contribution to capital under section 118 of the Internal Revenue Code. In United States v. Chicago, Burlington & Quincy Railroad Co., 412 U.S. 401 (1973), the Supreme Court adopted a two part inquiry to identify a non-shareholder contribution to capital: (1) the contributor motivation test and (2) the economic effect of the transferee test. The transferor's intent must be to enlarge the transferee corporation's capital to expand its trade or business for the benefit of the community at large and not to receive a direct or specific benefit for the transferor. For the requisite economic effect on the transferee corporation, the following five factors must be present:

- The contribution becomes a permanent part of taxpayer's working capital structure
- The contribution may not be compensation, such as direct payment for specific, quantifiable service provided for transferor by transferee
- The contribution must be bargained for
- The contributed asset must foreseeably result in benefit to the transferee in an amount commensurate with its value
- The contributed asset ordinarily, if not always, will be employed in or contribute to the production of additional income[47]

The U.S. Treasury has stated that disbursements that may be used for operating expenses will not qualify as a non-shareholder contribution to capital, while disbursements that are made to a corporation, restricted solely to the acquisition of capital assets to be used to expand the recipient's business—and satisfying the five factors—could be exempt from federal income tax. Such a favorable tax treatment on disbursements could reduce the broadband investment gap by up to $2.2 billion. Ultimately, the impact of taxes incurred will depend on the disbursement mechanism, as well as the tax situation of the service providers receiving support.

Assumption: Large service providers' current operating expenses provide a proxy for the operating expenses associated with providing broadband service in currently unserved areas.

As seen in Exhibits 1-A and 1-B, operating expenses (opex) make up a significant fraction of total costs. Complicating matters is that opex comprises many disparate cost elements: everything from the cost of operating the network (network opex) to the cost of sales and marketing, business support services, power, leases and property taxes (collectively overhead or SG&A). And because each service provider operates differently—there are no standards for how many lawyers, administrative-support staff or network technicians a company needs to hire per mile of plant or number of customers—it is not possible to calculate opex in a "bottom-up" approach.

To find a reasonable approximation of the opex associated with these networks, the team compiled publicly available data sources and ran a series of regressions. These regressions calculate the relationship between opex and already-calculated quantities like revenue or network capex (see CostQuest documentation for more information). Separate regressions are run for cable, telco and wireless companies; for each network type, opex is broken out according to the categories available in the data sources.

For each opex category, the analysis calculates the primary driver (i.e., the known quantity that most strongly correlates with the opex category). Thus some opex categories, like telco network opex, are driven off of network investments; wireless tower operations costs are driven off site counts; while other costs, such as marketing or bad debt, are calculated as a function of revenue. The ratio between the driver and the opex category (the coefficient of the regression) is calculated for different size operators in different geographies, though in some cases the impact of these factors is negligible.

Using this approach to estimate the real-world opex of actual companies (the same opex and companies that formed the source data) suggests that the approach is reasonable. Variations between the calculated and actual values of opex ranged from less than 1% to roughly 10%, depending on the cases studied.

Throughout the calculations described above, we assume that the opex associated with large telco and wireless providers is appropriate. If one instead assumed that a small telco and small wireless operator provided service, the gap would grow to $26.4 billion.[48, 49]

CHAPTER 3 ENDNOTES

1 *In the Matter of Represcribing the Authorized Rate of Return for Interstate Services of Local Exchange Carriers*, CC Docket No. 89-624, Order, 5 FCC Rcd 7507 (1990).

2 Note that model runs completed with a shorter time horizon (*see* User Guide for more information) will not include a terminal value. They will, instead, accelerate the depreciation and replacement of longer-lived assets, effectively requiring returns on those long-life assets in a shorter period of time.

3 Note that for census blocks with the largest area (likely the lowest-density census blocks); even census blocks may be too aggregated. *See*, for example, "State Broadband Data and Development Grant Program; Notice of Funds Availability, Clarification," 74 Federal Register 154 (12 Aug. 2009), pp. 40569 -40570.

4 Cable deployments are all new deployments that expand the cable plant; therefore all revenue is incremental.

5 HFC and FTTP networks also have scale lengths associated with them related to the distances of signal propagation in coaxial cable and fiber.

6 Verizon's LTE field trials in Boston and Seattle have shown average downlink rates of 5Mbps to 12Mbps and average uplink speeds of 2Mbps to 5Mbps at the time of this writing. *See* http://www.computerworld.com/s/article/9167258/LTE_speeds_faster_than_expected_in_Verizon_trials.

7 CITI BROADBAND REPORT AT 57.

8 In this example, we assume that the two networks are owned and operated by different entities. The cost impact of supporting two networks may be less severe in cases in which one company owns both networks.

9 The gap, specifically, is built from the *second*-least-expensive technology in each county across the country. Wireless with no competitors is used in all geographies; 12,000-foot-loop FTTN with one competitor is used in areas assumed to have 4G service, and with no competitors in other areas. *See* "Creating the base-case scenario and output" at the end of Chapter 1.

10 *High-Cost Universal Service Support; Federal-State Joint Board on Universal Service*, WC Docket No. 05-337, CC Docket No. 96-45, Notice of Proposed Rulemaking, 23 FCC Rcd 1495, para. 11 (2008).

11 The National Broadband Plan recommends identifying "ways to drive funding to efficient levels, including market-based mechanisms where appropriate."

12 The retail price of satellite service could exceed the price of terrestrial broadband. A "buy down" would ensure that those receiving satellite-based services would not face higher monthly rates than those served by terrestrial providers in other geographies. There is a sample buy-down calculation in Satellite portion of Chapter 4.

13 Satellite broadband and its ability and capacity to provide terrestrial-replacement service are discussed in Chapter 4.

14 *See* broadband-speed assumption section. *See also* Omnibus Broadband Initiative, *Broadband Performance* (OBI Working Paper, forthcoming) (Bowen, *Broadband Performance*).

15 All speeds throughout this paper are "actual" speeds. As with the National Broadband Plan itself, "actual speed" refers to the data throughput delivered between the network interface unit (NIU) located at the end-user's premises and the service provider Internet gateway that is the shortest administrative distance from that NIU.

16 *See* OBI, Broadband Performance.

17 Note that there were not enough data to complete an accurate predictive model of DSL actual speeds above 6 Mbps; therefore for speeds above 6 Mbps, the cable footprint is taken as the footprint of served housing units without augmentation from telco plant.

18 comScore, Inc., Jan.-June 2009 Consumer Usage database (sampling 200,000 machines for user Web surfing habits) (on file with the FCC) (comScore database).

19 Horrigan, John. Home Broadband Adoption 2009. Pew Internet & American Life Project: June 2009. *See* http://www.pewinternet.org/~/media/Files/Reports/2009/Home-Broadband-Adoption-2009.pdf.

20 Vanston, Lawrence K. and Vanston, John H. Introduction to Technology Market Forecasting. Austin, TX: Technology Futures, Inc, 1996. Note that we considered the Fisher-Pry model but ultimately concluded that, since it is geared toward modeling the substitution of a superior technology for an inferior one, it was not appropriate to use in this instance.

21 Geometrically speaking, the inflection point on the cumulative curve is the point at which the curve moves from convex to concave. The slope of the tangential line along the cumulative curve is highest at the inflection point, indicating maximum acceleration of adoption. Mathematically, the incremental curve is the first derivative of the cumulative, and the inflection point is at the maximum slope of the cumulative or maximum of the incremental curve.

22 Note that these calculations represent the investment gap for each individual technology; the $23.5 billion base case takes the second-lowest-gap technology in each county as described above, not the gap for any one technology.

23 Because we lacked precise data on the location of existing FTTP deployments, the figures for FTTP cost and investment gap are for a run that covers the entire country. Actual costs and gap would be reduced by the roughly 17 million HUs that are already passed by FTTP facilities.

24 The best fit, between modeled data (Gompertz) and observed data (Pew), in its least-squares sense, is an instance of the model for which the sum of squared residuals has its least value, where a residual is the difference between an observed value and the value provided by the model.

25 Each period on the x-axis represents one year, with the inflection point at zero.

26 Note that some demographic data, such as income, are calculated only at the census block group level; these geographically coarser data are applied "down" to the subordinate census blocks.

27 For Telco: 1) Proprietary CostQuest information and industry data/ financials (publically available) 2) Table 5 from FCC's June 30, 2008 Broadband Report
For Wireless: 1) http://wirelessfederation.com/news/17341-att-adds-1.4mn-mobile-subscribers-in-q2-usa/ (last accessed Mar. 24, 2010) 2) *See* SNL Kagan (a division of SNL Financial LC), "U.S. 10 year mobile wireless projections" 3) FCC "High Speed lines by Information Transfer Rates" as of June 30, 2008.
For Cable: 1) *See* SNL Kagan (a division of SNL Financial LC), http://www.snl.com/interactivex/CableMSOOperatingMetrics.aspx (Login required) templates that contained Q1 2004 – Q2 2009 data for: Basic Penetration; Basic Subscribers; Basic Homes Passed; Video Penetration Rates; Video Subscribers; Video Homes Passed; HSD Penetration Rates; HSD Subscribers; HSD Homes Passed; Voice Penetration Rate; Voice Subscribers; Voice Home Passed 2) *See* SNL Kagan (a division of SNL Financial LC), "Cable TV Projections, 2008-2019" 3) Publically available financials for the cable companies, including RCN; Knology; and General.

28 For Telco: Data were obtained from publicly available AT&T investor reports on U-VERSE (http://www.att.com/Common/merger/files/pdf/3Q09_U-verse-Update_10.22.pdf) as well as proprietary CostQuest information.
For Cable: Data were obtained from Forester: Williams, Douglas, et al. "MULTI-PLAY SERVICES: Driving Subscriptions in a Maturing Market and Down Economy", Volume 2, 2008.
For Wireless: Data were obtained from the Wireless Federation article, http://wirelessfederation.com/news/17341-att-adds-1.4mn-mobile-subscribers-in-q2-usa/ (last accessed Mar. 24, 2010).

29 *See*, for example, SNL Kagan (a division of SNL Financial LC), "Cable TV Projections, 2008-2019".

30 Dutz, Mark, Jonathan Orszag, and Robert Willig, "The Substantial Consumer Benefits of Broadband Connectivity for US Households," (July 14, 2009). *See* http://internetinnovation.org/files/special-reports/CONSUMER_BENEFITS_OF_BROADBAND.pdf.

31 *See* FCC, Industry Analysis and Technology Division, Wireline Competition Bureau, *Trends in Telephone Service Report ("Trends in Telephone* Service Report, Table 3.2 & 7.1 (August 2008), available online at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-284932A1.pdf.

32 *See* FCC, Industry Analysis and Technology Division, Wireline Competition Bureau, *Trends in Telephone Service Report ("Trends in Telephone* Service Report, Table 13.3 (August 2008), available online at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-284932A1.pdf.

33 *See* FCC, Industry Analysis and Technology Division, Wireline Competition Bureau, *Trends in Telephone Service Report ("Trends in Telephone* Service Report, Table 1.2 (August 2008), available online at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-284932A1.pdf.

34 In the Matter of Implementation of Section 3 of the Cable Television Consumer Protection and Competition Act of 1992 Statistical Report on Average Rates for Basic Service, Cable Programming Service, and Equipment, MM Docket No. 92-266, 21 FCC Rcd 2503 (December 2006) *available online at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-179A1.pdf.

35 *See* FCC, Industry Analysis and Technology Division, Wireline Competition Bureau, *Trends in Telephone Service Report ("Trends in Telephone* Service Report, Table 3.1 (August 2008), available online at http://hraunfoss.

CHAPTER 3 ENDNOTES

fcc.gov/edocs_public/attachmatch/DOC-284932A1.pdf; *See also* In the Matter of Implementation of Section 3 of the Cable Television Consumer Protection and Competition Act of 1992 Statistical Report on Average Rates for Basic Service, Cable Programming Service, and Equipment, MM Docket No. 92-266, 21 FCC Rcd 2503 (December 2006) *available online at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-179A1.pdf.

36 Tuning a propagation model involves significant drive testing to ensure simulated signal density correctly accounts for foliage, buildings, terrain and other factors which result in attenuation.

37 Cisco Ex-Parte Filing: A National Broadband Plan for Our Future, GN Docket No. 09-51, Cisco VNI Mobile Data (FCC filed 25 March, 2010).

38 ComScore 200,000 panel of machine survey (Jan-Jun 2009).

39 Cisco Ex-Parte Filing: A National Broadband Plan for Our Future, GN Docket No. 09-51, Cisco VNI Mobile Data (FCC filed 25 March, 2010).

40 *See* OBI, Broadband Performance.

41 2:1 assumption based on the average number of people per household and wireless penetration.

42 While the mobile voice ARPU of a user is $37 per month in model calculations, assuming one competitor on average in non-4G areas leads to a weighted-average mobile voice ARPU of $18.50.

43 Assuming, in other words, that a national carrier will not gain incremental revenue from deploying a fixed-broadband network.

44 26 U.S.C. § 61(a).

45 Includes Limited Liability Companies (LLCs) treated as a corporation for federal income tax purposes. This tax treatment would not apply to noncorporate entities such as partnerships, including LLCs treated as a partnership for federal income tax purposes.

46 The baseline classification is based on parameters in Exhibit 4-K in the following section. The remaining parameter sets alter the classification of flat and hilly terrains, as shown in Exhibit 4-Y. We highlight the changes in the parameters from the baseline for convenience.

47 Letter from William J. Wilkins, Chief Counsel, U.S. Department of Treasury, to Cameron K. Kerry, General Counsel, U.S. Department of Commerce (Mar.4, 2010).

48 The model attempts to capture the scale effects of operations by examining publicly available data. It is possible that there are additional scale effects not captured in this calculation; or that smaller companies could face costs even higher than in the source data.

49 This gap value is different from Exhibit 3-G. In this example, since we are comparing against the base case, the telco faces one competitor in 4G areas and zero in non-4G areas. Exhibit 3-G assumes the telco faces zero competitors in all areas.

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IV. NETWORK ECONOMICS

The United States has a diversity of both wired and wireless broadband networks which provides the vast majority of Americans with choices as to their broadband providers: most homes have a choice between wired broadband provided by a telephone network or a cable network. Telephone and cable networks were originally built for and funded by voice and video services respectively; but now, through upgrades, both are able to provide high-speed broadband to much of the country. Large investments in these networks are being made to further increase speed and capacity in the most profitable areas of the country. In addition to wired networks, there have been significant investments in wireless networks to provide broadband terrestrially via mobile and fixed wireless networks or via satellite. Like wired broadband, mobile broadband is likely to be provided over a network originally built for a different purpose—in this case mobile voice. Strong 3G mobile broadband adoption from smartphones, data cards and netbooks has driven operators to commit to large-scale upgrades to their wireless data networks using new 4G technologies. These new 4G technologies (WiMAX and LTE) can be used to provide broadband in higher speed mobile networks, fixed wireless networks and even hybrid fixed/mobile networks. Due to high costs and low capacity, satellites have primarily targeted customers in remote areas without other broadband options, but recently developed high-throughput satellites may change this.

BASIC NETWORK STRUCTURE

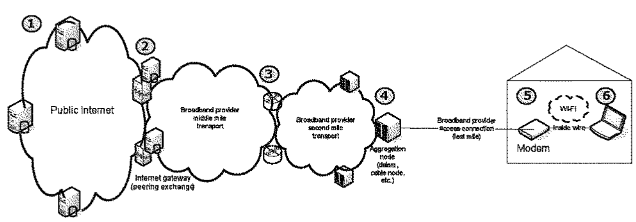
Exhibit 4-A is a diagram of the different portions of a broadband network that connect end-users to the public Internet. Starting at the public Internet, (1) content is sourced from various geographies and providers, data flow through the first peering point of the broadband provider (2), through the "middle mile" aggregation point (3) and "second mile" aggregation point (4), before being transported over either a wired or wireless "last mile" connection to the customer modem (5), which can either be embedded in a mobile device or standalone customer premise equipment (CPE), in the case of a fixed network. Once inside the premises broadband is connected to a device (6) through either wired or wireless connections (e.g. WiFi).

LAST-MILE TECHNOLOGY COMPARISON

We model the deployment economics of DSL/FTTN, FTTP, HFC, Satellite and 4G fixed wireless technologies. Each technology is modeled separately using detailed data and assumptions. Our model shows that fixed wireless and 12,000-foot-loop DSL have the best economics in delivering 4 Mbps down- and 1 Mbps up-stream to the unserved areas of the country.

Fixed wireless networks have favorable economics in most unserved areas, as the high fixed costs of wireless towers are amortized over many customers. In the least dense areas, particularly in mountainous terrain, however, there are few customers per tower and wired technologies are more economically efficient. Among wired networks, 12 kilofeet (kft) DSL has the best economics while still meeting the National Broadband Availability Target because it requires the least amount of network replacement/building. Although satellite capacity is

Exhibit 4-A: Basic Network Structure



DEFINITIONS

1. **Public Internet content:** Public Internet content that is hosted by multiple service providers, content providers and other entities in a geographically diverse (worldwide) manner
2. **Internet gateway:** Closest peering point between broadband provider and public Internet for a given consumer connection
3. **Link between second mile and middle mile:** Broadband provider managed interconnection between middle and last mile
4. **Aggregation node:** First aggregation point for broadband provider (e.g. DSLAM, cable node, satellite, etc.)
5. **Modem:** Customer premise equipment (CPE) typically managed by a broadband provider as the last connection point to the managed network (e.g. DSL modem, cable modem, satellite modem, optical networking terminal (ONT), etc.)
6. **Consumer device:** Consumer device connected to modem through internal wire or Wi-Fi (home networking), including hardware and software used to access the Internet and process content (customer-managed)

limited by the number of satellites, and latency can be an issue for some applications, the fact that costs are not dependent on population density makes it an attractive option for serving the most remote areas of the country. We model FTTP, HFC and 3-5 kft DSL as well, and even though the performance and revenue opportunities are better with these technologies, they have unfavorable economics in areas with low population density relative to the other technologies mentioned, due to the high fixed costs of building or replacing large parts of the network.

In order to accurately model each technology, we need to understand both the technical capabilities as well as the economic drivers. First, we determine which of the network technologies could meet end-user speed requirements. Then, we collect detailed cost data required to accurately model the build of a network with the required network capacity. Finally, we determine the incremental revenues that could be generated from each technology.

Network Capabilities

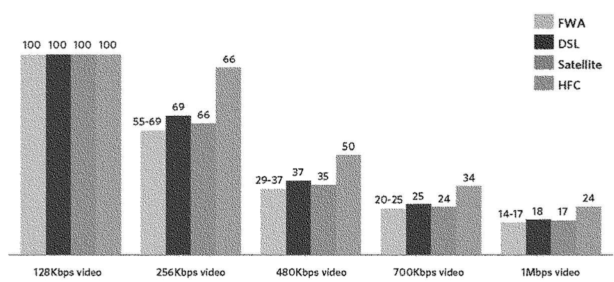
The National Broadband Availability Target is download speeds of 4 Mbps and upload speeds of 1 Mbps. As we shall see in later sections, we dimension the DSL/FTTN, HFC, FTTP, fixed wireless and satellite networks in our network model to meet the National Broadband Availability Target. Further, the sustained data rate capabilities of the networks are comparable.

For example, we compare the streaming capacities of the DSL, wireless, HFC and satellite networks as modeled in our analysis in Exhibit 4-B. For each of the cases, we consider a fully subscribed network, i.e., a network with the maximum prescribed subscriber capacity at the aggregation point nearest the end-users (a cell site in the case of wireless, a DSLAM/backhaul for DSL and a spot-beam for satellite). The details for each technology will be presented in following sections. For this analysis we assume the following: for wireless, a network of cell sites with 2x20MHz of spectrum, each with 650 subscribers;[1] for DSL, a network with about 550 subscribers[2] being served by a Fast-E second-mile backhaul link.

The exhibit shows the percentage of subscribers in each network that can simultaneously experience video streams of various rates. Thus, for example, we estimate that 29-37% of the wireless subscribers in the cell site can simultaneously enjoy a 480 kbps video stream.[3] For DSL and next-generation satellites, those numbers are 37% and 35%, respectively. So, each of the networks as dimensioned has comparable capabilities. We note that the capacity of an under-subscribed or under-utilized network will, of course, be higher. Thus, for example, if we used a Fast-E backhaul to serve a single 384-port DSLAM, then nearly 55% of subscribers can simultaneously enjoy a 480 kbps video stream.

However, the methods by which each technology can expand to meet growing capacity demand in the last mile differ. For example, with DSL, increased demand can necessitate two types of capacity upgrades that have very different remedies. First, when speed needs for a given user exceed the loop length capabilities on a DSLAM port (unshared network portion), the DSLAM is extended closer to the user so that the shortened copper loop can provide higher speed. This will involve fiber extension, electronics upgrades and significant outside plant reconstruction and rearrangement. This can be a very costly

Exhibit 4-B: Streaming Capacity of Modeled Broadband Networks [4]



Simultaneous streams in a fully subscribed network
Percent of subscribers of second aggregation point

process that involves many aspects of "new" construction, such as pole transfers/make-ready costs, fiber trenching and general overbuild of portions of the outside plant. And second, if the capacity expansion is a result of aggregate demand growth among the users sharing the second-mile backhaul of the network, and not the last mile, one only needs to upgrade DSLAM ports and increase backhaul capacity. Undoubtedly, this carries significant cost, but is relatively straightforward as it primarily involves electronics upgrades.

In the case of HFC, RF signals for data transmission are modulated onto coaxial cables and shared among all of the subscribers who are connected and active on the coaxial portion of the HFC network. Therefore, the last mile is a shared resource. One process for capacity expansion is cable node splitting, which involves electronics upgrades similar to DSL but often also requires significant outside plant reconstruction and rearrangement. Thus, it involves many aspects of "new" cable construction, such as pole transfers/make ready costs, fiber trenching and general overbuild of portions of the outside plant. While this process is not without significant cost and lead time, it is well understood and has been practiced for several years. In addition, there are a number of other often-used methods for increasing capacity as will be discussed in the HFC section.

Similarly, the last mile is shared in FTTP/PON networks. More precisely, optical signals are modulated onto fiber optic cables, which are then distributed to individual homes between the PON splitter and the home. Capacity expansion is again a matter of upgrading electronics either at the headend, home or both, and certainly requires rearrangement of PON splitters and other passive outside plant equipment but does not require a fundamental design and architecture change.

In the case of wireless communications, the primary shared resource in the last mile is the RF spectrum. Multiple wireless devices, such as mobile phones and wireless data cards, simultaneously transmit/receive over the same shared spectrum. In fact, an average cell site covers more than 4,000 people, often referred to as POPs or population.[5] As we will see later, the wireless networks that we model to deliver broadband will be capable of serving up to 650 homes per cell tower using a paired 2x20 MHz[6] of spectrum. Capacity expansion in the last mile typically involves using more spectrum or adding more cell sites or both.[7] Since wireless spectrum is a scarce resource, wireless capacity expansion can be expensive, involving many of the high costs of outside plant/tower construction, etc. (similar to wired technologies discussed above), unless the provider has adequate spectrum holdings. With adequate spectrum, however, capacity expansion is straightforward and relatively inexpensive. Spectrum needs in *unserved rural areas*—with low population densities—are expected to be limited. Given the amount of spectrum currently available and the additional spectrum likely to become available in the next several years,[8] we expect that capacity expansion in wireless should be relatively inexpensive in *these* areas.

Capacity expansion with satellites will ultimately involve launching additional satellites which are capable of providing more total bandwidth and higher spatial reuse of the available spectrum. New launches, however can cost up to $400 million and require potentially long lead times, as will be discussed later in this chapter.

All of the technology comparisons in this chapter are based on network builds that can meet the target, with an effective busy hour load assumption of 160 kbps (see later section on Network Dimensioning). A fundamental tenet is that the networks have been modeled such that users will receive an equivalent level of service and performance whether they are serviced by the fixed wireless 4G access network or a 12 kft DSL architecture.

Cost Comparison

Our model allows us to calculate the relative cost structure of different last mile technologies as a function of population density in unserved areas. As shown in Exhibit 4-C, the costs associated with all technologies are competitive in the highest densities and diverge as we move toward lower population densities. Note that Exhibit 4-C represents the present value of costs, not the gap associated with each technology.

HFC and FTTP costs are comparable and both are among the most costly in all densities. As one might expect, the cost of running a new connection to every home in low-density areas is very high. In effect, carriers face the cost of deploying a greenfield network in these areas.

Short-loop FTTN deployments (3,000- and 5,000-foot loops) realize some cost savings relative to FTTP from being able to avoid the last few thousand feet of buildout. These savings are particularly valuable in denser areas where operators are more likely to find more homes within 3,000 or 5,000 feet of a given DSLAM location. At the other extreme, in the least-dense areas, where a carrier might have only one customer within 3,000 feet of a DSLAM location, 3,000-foot FTTN is actually more expensive than FTTP; a fiber drop is less costly than a DSLAM. Longer-loop (12,000-foot) DSL is particularly low cost in higher-density areas, where the cost of a DSLAM can be amortized over more customers.

Wireless solutions are among the lowest cost solutions and wireless costs grow less quickly as density falls. As discussed in Chapter 3, and in more detail below, a major driver of wireless cost is cell size. The assumptions made about cell size in hillier terrain are larger drivers of cost than density; however, when ordering census blocks by density, as in Exhibit 4-C, this effect is averaged away and lost. More detail about the impact of cell size on cost is included later in this chapter.

Exhibit 4-C includes only costs, both capex and ongoing costs, and does not include revenue. Technologies that enable higher revenue could have lower investment gaps than costlier alternatives. Thus, it is possible that FTTP deployment could have a lower investment gap in some census blocks than FTTN or wireless. In addition, given the assumptions made about take rate and ARPU, wireless often will have a lower investment gap than a less-costly 12,000-foot-DSL solution.

However, as noted in Chapter 3, evaluating the economics of technologies over areas as small as a census block makes little sense. Counties or other service areas draw census blocks from across multiple densities. Therefore this revenue-driven advantage is muted when census blocks are aggregated into counties or other service areas and wireless and 12,000-foot-loop DSL are the lowest investment-gap terrestrial solutions overall.

TECHNOLOGIES INCLUDED IN THE BASE CASE

As seen in Exhibit 4-C, our model indicates fixed wireless and 12 kft DSL are the low-cost terrestrial solutions that are capable of delivering speeds consistent with the Broadband Availability Target in unserved areas. We will focus on those technologies and satellite across the next three sections, before returning to those technologies with higher deployment costs.

Wireless Technology

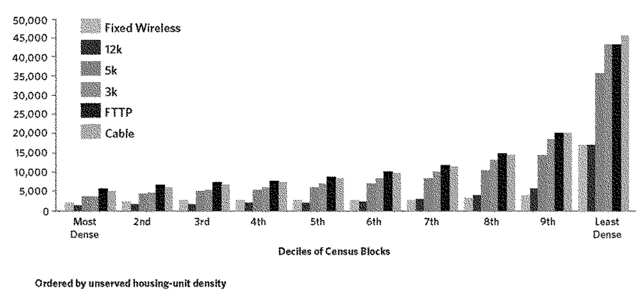
The first mobile networks were built when the FCC approved commercial car-phone service in 1946 but the first commercial cellular telephony service in the United States came in 1983 using AMPS technology. AMPS was an analog phone service that was still in use in some regions of the United States as recently as 2008. As wired communications started going digital in the 1980s, so did wireless telephony. In the 1990s there were four different 2G digital wireless technologies used in the United States: CDMA-based IS-95, TDMA-based IS-54 (often called Digital AMPS or D-AMPS), GSM and iDEN. Initially, these technologies provided voice services and some limited circuit-switched data services like SMS with peak data rates of 9.6 kbps.

CDMA and GSM became the predominant technologies in the United States, with more than 71% of subscribers in 2004.[9] For GSM, the first real step towards packet-based data services was GPRS, which was later replaced by EDGE. Even with EDGE, the average data rates were still only 100-130 kbps. The big step towards mobile broadband for GSM providers came with UMTS or WCDMA, a CDMA-based air interface standard; average user data rates were 220-320 kbps. Over time, the standards bodies created HSDPA for the downlink and HSUPA for the uplink, collectively referred to as HSPA today. User data rates of up to several Mbps became possible,[10] allowing GSM-family providers to offer true 3G service. See Exhibit 4-D.

Like GSM, CDMA rapidly evolved, first into CDMA2000 1xRTT which delivered peak data rates of 307 kbps and later into CDMA2000 EV-DO that is capable of delivering data rates of up to 3.1 Mbps.

There are two competing 4G standards that can be used in wireless broadband networks:[11] LTE, which is an evolution of the GSM family of standards, and WiMAX. Both of these technologies use OFDMA modulation instead of CDMA and, as such, are not backward compatible with either HSPA or EV-DO. The 4G technologies are only beginning to be deployed and adopted. In fact, LTE, one of the most anticipated

Exhibit 4-C: Present Value of Total Costs for All Technologies in Unserved Areas[12]



4G technologies, has yet to be commercially deployed in the United States as of the time of this writing, while WiMAX covers less than 3% of the population.[13]

Evolution of the Performance of Wireless Technologies

As wireless technologies have evolved, so have their performances. In a broad sense, with every evolution the industry has achieved higher peak throughputs, improved spectral efficiencies and lower latencies. Additionally, with 4G the wireless signal can be transmitted over wider bandwidths of up to 20MHz,[14] which further increases spectral efficiency and network capacity, while letting the user experience higher data rates. Additionally, 4G uses a native, all-IP architecture, thus benefitting from the technology and economic efficiencies of IP networks.

The most important dimension of performance—at least as far as capacity of the wireless network is concerned—is spectral efficiency, which is the number of bits/second that a sector can transmit per hertz of spectrum. As such, spectral efficiency drives average downlink data capacity of a cell site linearly. Exhibit 4-E shows the evolution of the average downlink and uplink data capacities of a single sector in a three-sector cell site for the GSM family of standards.[16]

Note that there is no known analytic form for Shannon capacity for a multi-user, multi-site wireless network today. However, one can estimate the Shannon limit for a single user on a single cell site. Further, scheduling efficiency gains from multi-user scheduling are well understood.[17] One can therefore estimate the capacity of a multi-user, multi-site network.[18] But, this estimate does not take into account potential future gains in wireless technology and networks from, for example, coordinated transmission of data to users from multiple cell sites. Nonetheless, this estimated limit suggests that gains in spectral efficiency—and the ability of networks to cheaply improve performance or capacity—will likely be limited in the future.

In fact, as illustrated in Exhibit 4-E, we estimate that the latest release of the LTE standard brings us to within 25% to 30% of the maximum spectral efficiency achievable in a mobile network. Going forward, improvements in spectral efficiency are likely to result from techniques that include the use of new network architectures and multiple-antennas.[19] Specifically:

- Multiple-antenna techniques, such as spatial multiplexing in the uplink and improved support for beamforming
- Network enhancements:
  - Coordinated transmission of data to users from multiple cell sites
  - Relays or repeaters to improve coverage and user experience at cell edges with low additional infrastructure cost
- Carrier or spectrum aggregation to achieve higher user burst data rates

The 4G network architecture represents an evolution as well. 3G networks, having evolved from legacy 2G architectures that were primarily designed for circuit-switched traffic, were hierarchical in design and included many more network elements. 4G, on the other hand, optimizes the network for the user plane and chooses IP-based protocols for all interfaces.[20] The result: a much simpler architecture with far fewer network elements. Not only does this reduce capex and opex for 4G networks relative to 3G, but it also means reduced network latencies; see Exhibit 4-F. The performance of TCP/IP, the Internet data transport protocol, is directly impacted by latency,[21] so that reduced latencies translate directly into improved user experiences.

BOX 4-A

Wireless Multiple Access 101

In any wireless network with multiple users, those users must share the wireless communication channel. Different technologies use different schemes for sharing the channel; these schemes are commonly referred to as multiple access schemes. One such scheme is Time Division Multiple Access, or TDMA, which divides the channel into multiple time slots, allocating each to one of many users. The users then communicate with the base station by transmitting and receiving on their respective time slots. TDMA is used in GSM/GPRS/EDGE as well as the eponymous TDMA IS-54 standard.

Another scheme is Code Division Multiple Access or CDMA. It uses *spread-spectrum* technology for sharing the physical communication channel between the users. More precisely, in CDMA, the signal to and from each user is modulated using a uniquely assigned code. This modulated signal on the assigned code is spread across far more bandwidth than the bandwidth of the data being transmitted. This allows multiple users to simultaneously transmit or receive communication signals on the channel, which are then separated at the base station using the codes. CDMA allows for greater spectral efficiency than TDMA where communication to each user takes place in a uniquely assigned time slot. All 3G technologies, EV-DO and UMTS/HSPA, use CDMA, as does IS-95 and CDMA 1xRTT.

Finally, in Orthogonal Frequency Division Multiplex Access or OFDMA, data transmission occurs on a set of orthogonal *sub-carriers* assigned to each user; the sub-carriers are then modulated and transmitted using conventional modulation techniques. OFDMA has emerged as the multiple access technique for 4G technologies.[15]

Exhibit 4-D:
Different Wireless Technology Families Have Evolved Over Time[22]

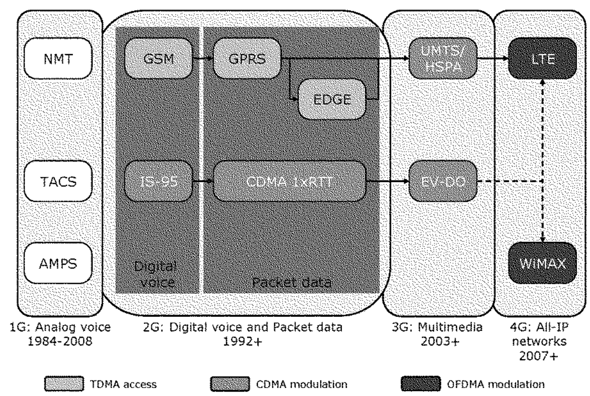
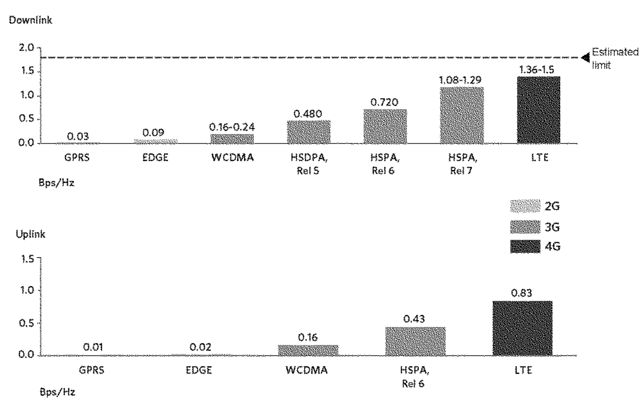


Exhibit 4-E:
Downlink and Uplink Spectral Efficiencies by Technology[23]



4G Deployment Plans

Exhibit 4-G shows projected 4G deployment plans for major carriers in the United States based on public announcements.[24] Verizon Wireless has the most aggressive deployment schedule for LTE. It plans to build out to 20 to 30 markets in 2010, extending to its entire EV-DO footprint by 2013—thus reaching more than 93% of the U.S. population.[25] AT&T has announced that it will be trialing LTE in 2010, then rolling it out commercially in 2011. Sprint plans to deploy WiMAX through its partnership with Clearwire. WiMAX has been rolled out in a few markets already and Clearwire announced plans to cover 120 million people by the end of 2010. With carriers in the United States and around the world making these commitments to deploy 4G, we expect it to have significant benefits of scale: a robust ecosystem, strong innovation and substantive cost savings.

Given the superior performance of 4G and the likely extensive 4G coverage by 2013, we shall limit our wireless analysis to 4G technologies in the rest of this document. Our goal is certainly not to pick technology winners, and we recognize that other wireless technologies, such as WiFi mesh, cognitive radios and even 3G, will be important parts of the broadband solution. However, these technologies are unlikely to deliver a cost-effective and reliable wide-area broadband experience consistent with the National Broadband Availability Target in unserved communities. To the extent these technologies offer appropriate service at comparable or lower prices, they will certainly play a role.

Fixed Wireless Access (FWA) Networks

By FWA networks, we refer to wireless networks that use fixed CPEs in addition to (or, possibly, even instead of) mobile portable devices. FWA solutions have been deployed as a substitute for wired access technologies. For example, FWA networks are being used commercially in the U.S. by Clearwire with WiMAX and Stelera with HSPA, and globally by Telstra

Exhibit 4-F: Evolution of Round-Trip Latencies in Wireless Networks, in Milliseconds[26 27]

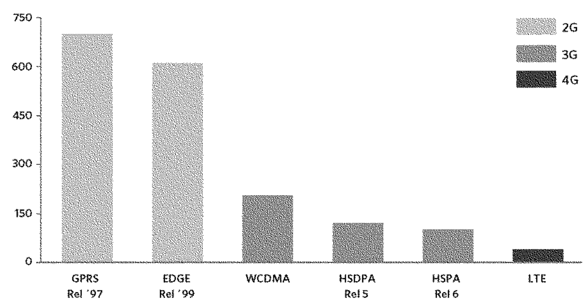


Exhibit 4-G: Publicly Announced 4G Wireless Deployments

Technology	Companies	2009	2010	2011	By 2013
LTE	• Verizon • AT&T • MetroPCS • Cox		• Verizon (100MM) • AT&T (Trials)	• AT&T (start deployment) • Cox (start deployment) • MetroPCS (start deployment)	• Verizon (entire network)
WiMAX	• Clearwire/Sprint • Open Range • Small WISPs	• Clearwire (30MM) • WISPs (2MM)	• Clearwire (120MM)		• Open Range (6MM)

with HSPA. In addition to the larger providers, there are hundreds of entrepreneurial and independent Wireless Internet Service Providers (WISPs) who provide fixed wireless services to at least 2 million customers in rural areas, including many areas not covered by the national wireless companies.[28] Such deployments are particularly attractive in areas where wired competitors do not exist or have inadequate capabilities.

Fundamentally, FWA uses fixed CPE to deliver better performance by improving end-user signal quality. Examples of techniques that allow fixed wireless to provide superior performance compared to mobile broadband include:

- CPE techniques:
  - Using a higher power transmitter than would be possible with a battery-powered end-user device in order to improve the upstream data rate and/or increase the coverage area
  - Using large high-gain antennas along with external mounting to decrease building loss and further improve both upstream and downstream data rate and/or increase the coverage area
  - Placing the antenna in a favorable location to achieve line-of-sight or near line-of-sight to reduce path loss
- Base Station techniques: using stronger power amplifiers and multiple antenna techniques in order to increase the coverage area and/or capacity

These techniques are broadly applicable to most spectrum bands and to both 3G and 4G technologies. As such, generally speaking, FWA networks can support both fixed and mobile traffic, with fixed CPEs improving the performance of fixed service relative to mobile.

Our objective is to provide fixed broadband service to homes; so, we have used the performance characteristics of a FWA network in our network model. *In what is to follow, unless otherwise mentioned, the term wireless network will refer to a FWA network.*

Complexity of Analyzing Wireless Networks

It is important to recognize that a wireless network has several layers of complexity that are not found in wireline networks, each of which affect the user experience and, therefore, network buildout costs and the investment gap. For example, the location of the user relative to the cell site has a significant impact on data rates. More precisely, those at the cell edge, i.e., farthest from the cell site, will have much lower signal quality than those closer to it. And as signal quality drops, throughput drops as well; thus, at the cell edge a user may experience more than 60% degradation in data rates relative to the average experience within the cell.[29]

Another factor affecting user experience is the fact that wireless spectrum is shared by all the users in the cell. As a result, a user can experience significant variations at the same position in the cell depending on temporal changes in capacity demand (or loading).

There are other factors that lead to a heterogeneity of user experience. For example, the wireless signal itself undergoes different levels of degradation depending on terrain, user mobility and location (indoors vs. outdoors vs. in-car). Further, there is a wide range of end-user device types, which vary in their peak bandwidth capabilities, have different types of antennas, form factors, etc. Each of these factors can lead to a different user experience under otherwise identical conditions.

Consequently, analysis of the performance of wireless networks requires a statistical approach under a well-defined set of assumptions. We shall describe the assumptions behind the parameters we used in our wireless network model. However, it is possible that the parameters in an actual network deployment are different from those that we estimated. Improving the accuracy of our estimates would require a RF propagation analysis in the field—an extremely time-consuming and expensive proposition that is usually undertaken only at the time of an actual buildout. And even that approach will not always capture some effects, such as seasonal foliage.

Approach

Exhibit 4-H is a schematic that lays out our approach to analyzing the cost of the network buildout. The cost of the network, as shown, is driven by the number of cell sites required to deliver broadband service and the cost of building, operating and maintaining each cell site.

The number of cell sites required to serve an area is fundamentally dependent on capability of the technology. Using the performance of LTE networks, we dimension cell sites to deliver downlink and uplink speeds of 4 Mbps and 1 Mbps, respectively, in two steps:

- First, we ensure that the cell sizes are dimensioned to provide *adequate signal coverage*; i.e., absent any capacity limitations, the propagation losses within the coverage area are constrained and, therefore, the received signal strengths are adequate for delivering the target data rates. Our analysis indicates that the uplink requirement is the driver of coverage limitations.
- Next, once we have ensured adequate signal coverage, we ensure that each cell site has sufficient *capacity* to meet the traffic demand. We achieve this by constraining the maximum number of subscribers per cell site. As mentioned in Network Dimensioning, we only consider the downlink capacity requirements—and not the uplink—for our analysis.

Following that, we present the economics of a wireless network. In particular, we analyze the influence of factors like spectrum, terrain and downlink capacity on wireless economics. We also discuss in detail the factors that influence the cost of building and operating a cell site, namely tower lease/construction and backhaul for cell sites.

Dimensioning the Network for Coverage

The method of determining the maximum cell radius to ensure sufficient coverage in the modeled network is driven by three key factors (see Exhibit 4-I):

- Broadband rate targets and the corresponding link budgets: Link budgets allow us to calculate the Maximum Acceptable Propagation Loss (MAPL) of the transmitted signal such that the received signal quality is adequate for achieving the target data rates.
- Spectrum bands: The propagation characteristics of spectrum bands are different, thereby impacting cell radius.
- Terrain: It plays an important role in radio propagation. Simply put, mountains and hills block wireless signals; so areas with rougher terrain require smaller cell radii than areas with flat terrain.

Link Budgets

In order to deliver uplink speeds of 1 Mbps within 90% of the cell coverage area in a FWA network, the maximum acceptable propagation loss (MAPL) is 142 to 161 dB; see highlighted text in Exhibit 4-J. By contrast, the MAPL in a mobile environment is 120 to 132 dB. In other words, higher power CPEs with directional antennas placed in favorable locations in a FWA network yield gains of more than 20 dB over mobile devices.[30]

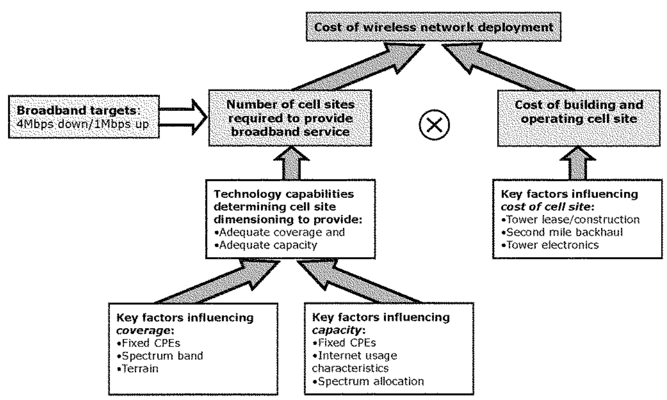
For our target data rates, it is the uplink that drives coverage limitations; i.e., the cell radius limits imposed by the uplink link budget calculation are smaller than the radii required to ensure adequate downlink received signal strengths. A cell radius small enough for a 200 mW handheld device or a 500 mW FWA device to deliver adequate signal strength to the base station is also small enough for a 40 W (macro) base station to deliver more than adequate downlink signal strengths.

Loosely speaking, unless the downlink and uplink requirements are more asymmetric than the power differential, the significantly higher power at the base station implies that adequate uplink coverage should result in adequate downlink coverage.[31]

Impact of spectrum bands

Cellular service today typically operates in one of several bands: from 700 to 900 MHz; from 1.7 to 2.1 GHz; and from 2.5 to 2.7GHz (see Chapter 5 of National Broadband Plan for details). Generally speaking, in this range of frequencies lower frequency signals suffer lower propagation losses and therefore travel farther, allowing larger cell sizes. Lower frequency signals also penetrate into buildings more effectively. Thus, for example, the Okumura-Hata model[32] predicts that the radius of rural cells in the 700MHz band can be as much as 82% greater

Exhibit 4-H: Approach for Analyzing Cost of FWA Network



than in the PCS band for comparable coverage. In suburban areas this benefit is 105%, while in urban areas the improvement is greater than 140%. That makes lower frequency bands better suited for coverage and deployments in rural areas.

Terrain classification and maximum cell size

Terrain plays an important role in radio propagation, an effect that cannot be captured using propagation loss models such as the Okumura-Hata model.[33] Since mountains and hills block wireless signals, areas with rougher terrain require smaller cell radii than areas with flat terrain.

To account for this effect of terrain, we classified terrain into each of the four categories shown in Exhibit 4-K. More precisely, we used GIS data to classify each Census Tract (CT),[34] based on elevation variations across one square Km grids, into one of the four categories.

Exhibit 4-I: Methodology for Determining Maximum Cell Radius for Coverage

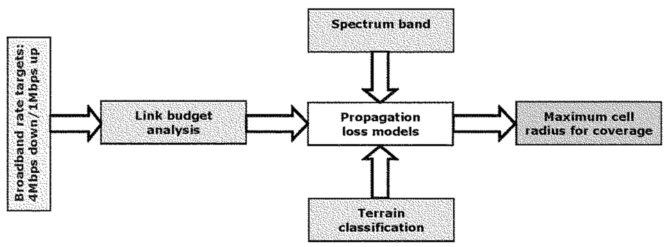
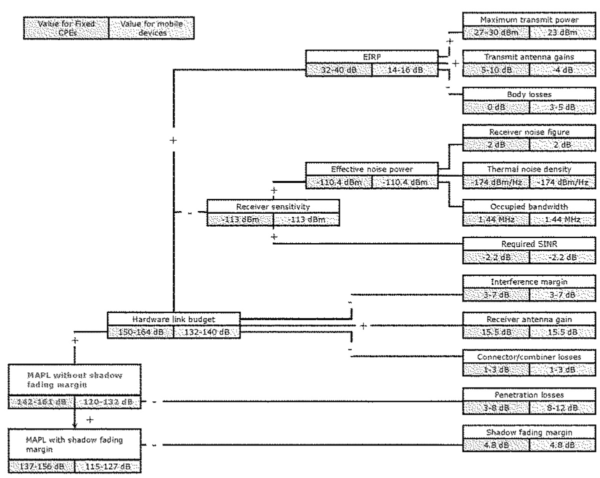


Exhibit 4-J: Link Budget for Delivering 1.26 Mbps Uplink Speeds at 700MHz [35,36]



Recall from the discussion of link budgets that the Maximum Allowable Propagation Loss (MAPL) for achieving our target broadband speeds is 142–161 dB. We use RF planning tools[37] (see Exhibit 4-M) to estimate the cell radius for each terrain type that will keep propagation losses within bounds.[38] More specifically, we choose the MAPL to be 140 dB, allowing for possible propagation losses due to foliage.[39] Areas in green in Exhibit 4-M correspond to areas with adequate signal coverage. The results of this analysis are shown in Exhibit 4-L for the 700MHz band.

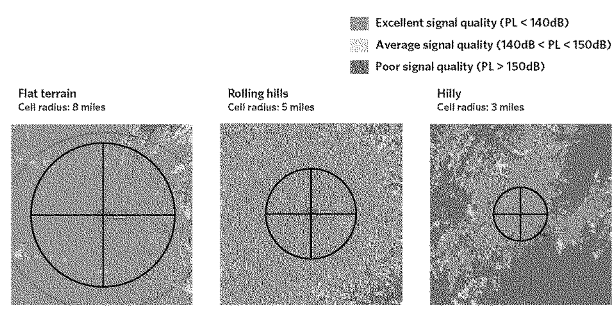
Exhibit 4-K:
Classification of Terrain of Census Tracts

Terrain type	Standard deviation (SD) of elevation (meters)	Examples
Flat	≤ 20	Topeka, Kan.; SD = 12 King City, Mo.; SD = 19
Rolling hills	20 to 125	Manassas, Va.; SD = 41 Lancaster, Pa.; SD = 45
Hilly	125 to 350	Lewisburg, W.V.; SD = 167 Burlington, Vt.; SD = 172
Mountainous	≥ 350	Redwood Valley, Calif.; SD = 350

Exhibit 4-L:
Maximum Cell Radius for Adequate Coverage in the 700MHz Band

Terrain type	Examples	Maximum cell radius (miles)
Flat	Topeka, Kan. King City, Mo.	8
Rolling hills	Manassas, Va. Lancaster, Pa.	5
Hilly	Lewisburg, W.V. Burlington, Vt.	3
Mountainous	Redwood Valley, Calif.	2

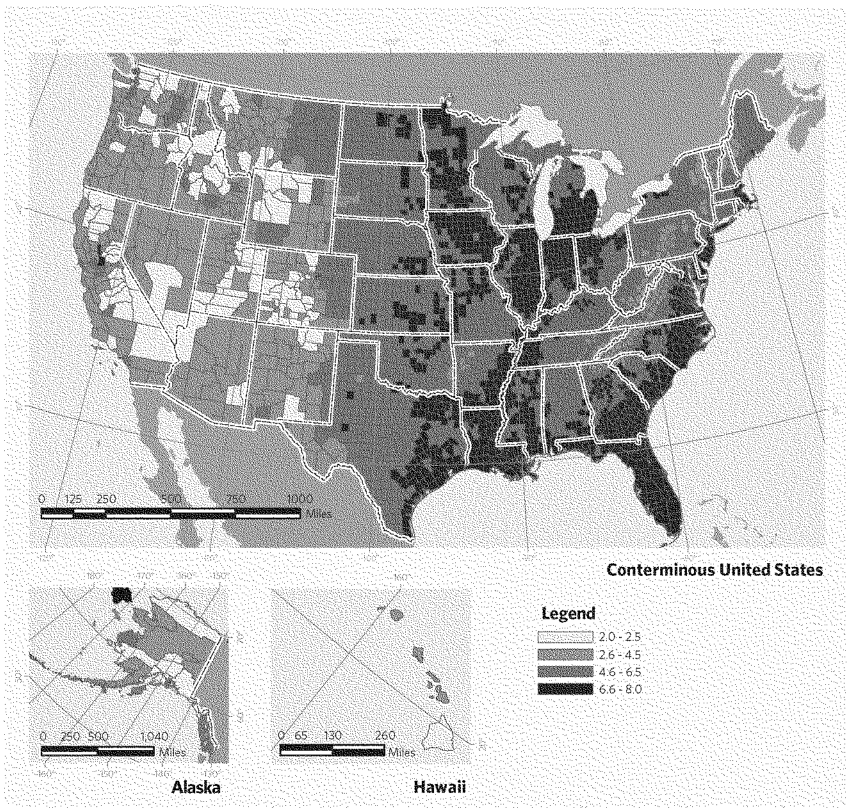
Exhibit 4-M:
Propagation Loss for Different Terrain Types at 700MHz[40]



We show a terrain map of the continental United States in Exhibit 3-X; average cell radii for each county based on the classification in Exhibit 4-L for the 700MHz band are shown in Exhibit 4-N. Finally, Exhibit 4-O quantifies the number of households by the cell sizes required to provide adequate coverage to them. Note that only around 13% of housing units (HUs) are in hilly or mountainous areas.

Finally, the propagation characteristics of the spectrum band clearly impact coverage. But, spectrum availability does not play an explicit role in our analysis. Certainly the

Exhibit 4-N:
Average Cell Size in Each County (in miles)



aggregated uplink *capacity* at a cell site improves with spectrum, but the only way to increase the maximum achievable data rate for a *specific user* is to reduce cell size. In other words, site counts will increase if we increase the uplink data rate requirement; adding more spectrum will not alleviate the problem.

Dimensioning the Network for Capacity

Exhibit 4-P shows that subscriber capacity of the wireless network depends primarily on the following:

- Broadband requirements and traffic characteristics. The first represents the National Broadband Availability Target of 4 Mbps downlink while the latter is a characterization of the demand for network capacity, generated by the subscribers on the network (see also Network Dimensioning section).
- Spectrum allocation. Loosely speaking, if spectral efficiency of the air interface remains unchanged, capacity of the wireless network grows proportionately with spectrum allocation.
- Fixed CPE with directional antennas. Specifically, the improvement in signal quality and data rates resulting from using directional antennas at CPE.

We then use the performance of LTE networks to determine the maximum subscriber capacity of the FWA network.

Importantly, signal quality or Signal to Interference and Noise Ratio (SINR)[41] in the downlink is not significantly impacted by increasing the transmission power in cells that are not coverage (i.e., signal strength) limited. This is because signal attenuation depends on the distance from the transmitter, so that SINR depends on the distance of the user from the *serving*[42] cell site relative to the other interfering cell sites. So, if we increase transmission power of all cells similarly, both received signal power and interference power increase proportionately and the net improvement in SINR is small. Correspondingly, reducing the radius of all cell sites proportionately also has a relatively small impact on SINR distribution.

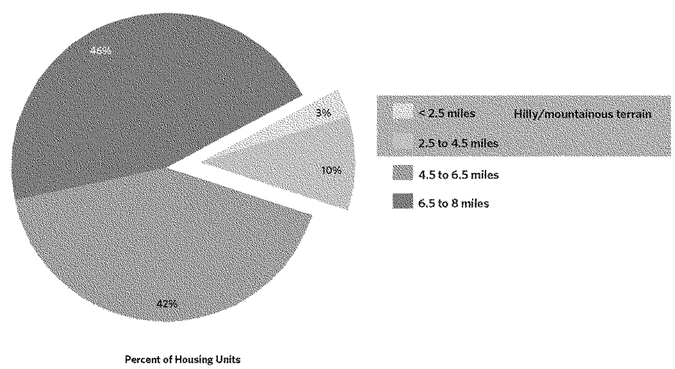
Requirements and Traffic Characteristics

Exhibit 4-Q shows our estimate of the maximum number of subscribers in a FWA cell site for different spectrum allocations.[43] This estimate includes the impact of directional antennas in fixed CPE as discussed below.

As noted in the section on coverage, cell radii are chosen to ensure that the signal quality is adequate for delivering 4 Mbps downlink and 1 Mbps uplink. However, since spectrum is a shared resource, we must ensure that the network is also capable of providing sufficient capacity to deliver these speeds. The approach to sizing the number of subscribers therefore is to first characterize network usage using the Busy Hour Offered Load (BHOL) metric; see Network Dimensioning for details. We assume the BHOL per subscriber is 160 kbps. Then, we use the performance of LTE networks to determine the maximum number of subscribers per cell site for different spectrum allocations such that users achieve the broadband-speed target 95% of the time when the BHOL is 160 kbps.[44]

Note that we achieve our target downlink data rate by limiting the maximum subscribers per cell site, which can be

Exhibit 4-O:
Coverage of Unserved Housing Units by Cell Radius



interpreted to be a limit on cell size. But we remarked earlier that we cannot increase data rates by reducing cell size—a seeming contradiction. The resolution is that reducing cell size does not improve signal quality unless it results in a reduction in the number of subscribers per cell site. For example, the user-experience in two cells with 100 subscribers each will not be materially impacted if the cell radius of each is 1/2 km instead of 1 km. Since the load on the network will not change in either case, the utilization is unchanged as well. If we now introduce two additional cells into this hypothetical network, such that each cell has 50 subscribers, then we will see an improved user experience because fewer subscribers in each cell will imply reduced load in each cell. That, in turn, will reduce each cell's utilization and, thereby, improve signal quality and end-user data rates.

So, we cannot prescribe a maximum cell radius to achieve a target downlink data rate (because population density across geographies is not uniform). But we can limit subscribers per cell to achieve target speeds.

Fixed CPE with directional antennas

Using fixed CPE with directional antennas can result in more than a 75% improvement in spectral efficiency over CPE with omni-directional antennas.[45] More significant is the gain in data rates at the cell edge. We illustrate this in Exhibit 4-R. Specifically, the chart on the left shows the improvement in SINR distribution in the cell site when the network has CPE with directional antennas instead of omni antennas. For

Exhibit 4-P: Methodology for Dimensioning Wireless Networks to Provide Adequate Capacity

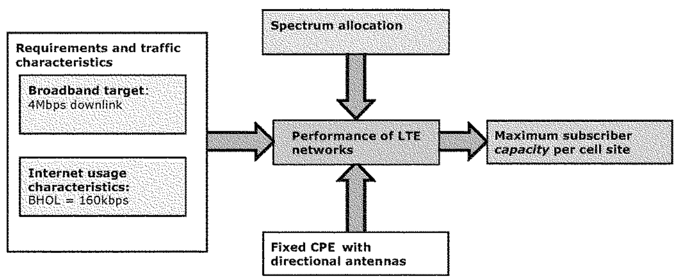
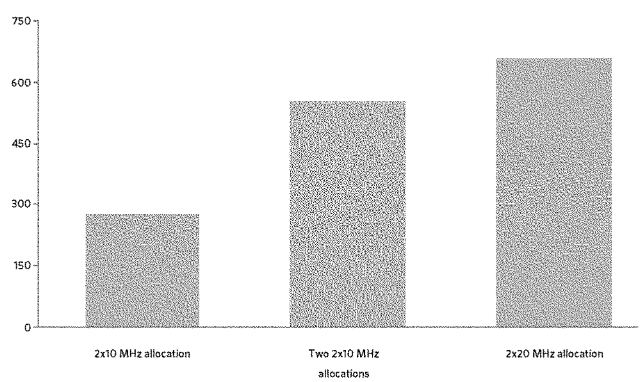


Exhibit 4-Q: Maximum Number of Subscribers Per Cell Site in an FWA Network with Directional Antennas at the CPE[46]



example, nearly 35% of users in a network with omni antennas have a SINR of 0 dB[47] or worse. By contrast, less than 1% of the users in a network with directional antennas have a SINR of 0 dB or worse. The significant boost in signal quality is a result of (a) improved signal reception with the higher antenna gain of a directional antenna and (b) reduced interference due to the increased interference rejection possible with such antennas.

This improvement in SINR directly translates to better data rates. For example, if a CPE with an omnidirectional antenna experiences a data rate of ~3 Mbps, then a CPE with a directional antenna will experience an average of ~9 Mbps under otherwise identical conditions.

Spectrum allocation

We mentioned above that lower spectrum bands are better suited for coverage. Higher frequency spectrum, on the other hand, is better suited for capacity by deploying Multiple Input and Multiple Output, commonly referred to as MIMO,[48] solutions. This is because smaller antennas can be used at higher frequencies and multiple antennas can be more easily integrated into handsets constrained by form factor. As such, deployments in these bands can have higher spectral efficiency. That is not to say that MIMO cannot be deployed in the lower frequency bands; rather, MIMO solutions are more practical and cheaper in the higher bands.

In our model, we assume 2x2 MIMO,[49] which is easily implemented in the 700MHz band in a FWA network.

The importance of spectrum towards ensuring a robust mobile broadband future has been discussed at length in the Chapter 5 of the NBP. In this section, we discuss how spectrum availability impacts subscriber capacity. For convenience, we shall assume the propagation characteristics of the 700MHz band for this discussion.

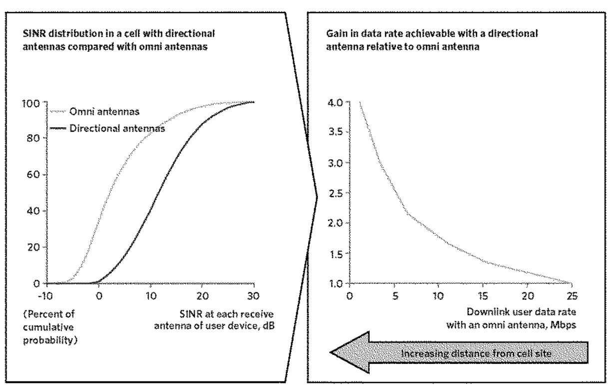
In Exhibit 4-Q, we saw that the capacity of a network with two paired 2x10MHz carriers[50] is twice that of a single 2x10MHz carrier. That should not be surprising. Interestingly, however, the capacity with a single 2x20MHz carrier is 20% higher than with two 2x10MHz carriers.[51] This is, in part, due to the better statistical multiplexing possible with the first option (using the wider carrier). Most of these gains will also be achievable with the second option once carrier/spectrum aggregation is introduced in the LTE standard.

Exhibit 4-S shows the spectrum needs in 2020 and 2030 for *coverage* cell sites in the unserved regions of the United States. Recall that coverage cell sites provide adequate downlink and uplink coverage (i.e., 4 Mbps/1 Mbps downlink/uplink speeds at the cell edge); however, depending on the number of households within the cell site, it may not have enough capacity to meet the traffic needs.

For our baseline model, we assume that 2x20MHz of spectrum is available per cell site. So, as the figure shows, in 2020, 94% of the *coverage* cell sites will also have adequate capacity. The remaining cells need techniques such as cell-splitting or 6-sector cell sites to increase capacity.[52] As the uptake continues to increase, the spectrum needs will also increase, as shown by the chart on the right.

This analysis is based on an average BHOL per subscriber of 160 kbps. Higher data usage than that will indeed increase spectrum needs. Still, the analysis shows that spectrum needs are

Exhibit 4-R: Impact of Directional Antennas at CPE on SINR[53,54]



relatively modest, due to three reasons. First, we used a FWA network, which has higher capacity than a mobile one. Second, the population density in the unserved regions is very low—less than 10 HUs per square mile. Consequently, the number of subscribers per cell site and the traffic demand per cell site are also relatively modest. Finally, the uplink coverage requirement of 1 Mbps resulted in a much higher cell site density than would otherwise be necessary, which further reduced the number of subscribers per cell site.

We end this discussion on spectrum availability by contrasting the difference in impact spectrum has on uplink and downlink dimensioning:

- In order to achieve a target *uplink* user data rate, we limit the maximum cell radius to ensure sufficient *coverage*. And while propagation characteristics of the spectrum band are important for our calculation of maximum cell radius, spectrum availability has little impact—the uplink signal received at the cell tower, not the availability of spectrum, is the limiting factor.
- In the *downlink*, on the other hand, we are limited by cell site *capacity*. We can either reduce the cell size to match subscriber demand with capacity, or we can add spectrum to the cell site, because more spectrum implies more capacity. The first option is more expensive, because the incremental cost of using additional spectrum at a cell site is smaller than the construction costs associated with cell-splitting if spectrum is available.

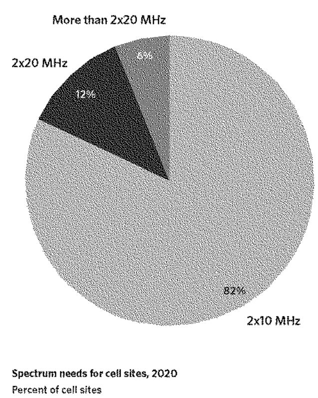
Therefore, the overall impact of spectrum availability on network buildout depends on the evolution of downlink and uplink usage characteristics. Specifically, let us consider two extreme scenarios:

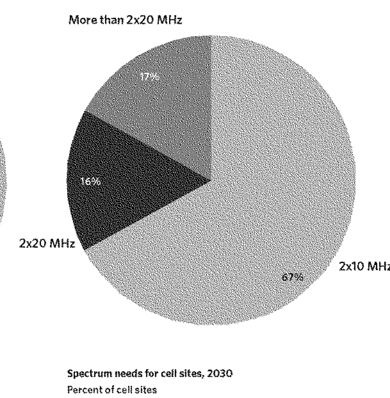
- **Extreme uplink usage**: If uplink usage were to evolve disproportionately faster than the downlink, then the only way to dimension the network would be to reduce the cell size. In doing so, we reduce the number of subscribers per cell site. That, in turn, automatically reduces the downlink capacity needs per cell site so that spectrum plays a less critical role in the solution.
- **Extreme downlink usage**: If, on the other hand, downlink usage evolves disproportionately faster than the uplink, then availability of spectrum can significantly mitigate the need for additional cell sites. That, in turn, significantly reduces the cost of network capacity expansion.

Second-Mile Backhaul

A key requirement of wireless broadband networks is high-capacity backhaul, a need that will only grow as end-user speed and effective load grow. Today, even though 97.8%[55] of the U.S. population has 3G coverage, most cell sites are still copper fed. For example, Yankee Group estimates that more than 80% of cell sites are copper fed.[56] Further, Sprint Nextel noted that in its network, "most towers carry between one and three

Exhibit 4-S: Spectrum Needs for Cell Sites in 2020 and 2030, Based on BHOL of 160 kbps





DS-1s" and that "almost no towers have more than five DS-1s."[57] This is important because copper facilities will have inadequate speeds for a well-subscribed 4G cell site; so, without adequate upgrades, backhaul can quickly become the choke point of the network (see Exhibit 4-T). Additionally, both fiber and microwave avoid some of the reliability problems often found in dealing with copper-based backhaul. Said differently, dimensioning adequate backhaul is one of the key drivers for providing wireless broadband. As shown in Exhibit 4-T, for our purposes we need backhaul capacity that can only be provided by fiber and/or microwave.

In unserved areas, microwave point-to-point backhaul is a potentially attractive alternative to fiber for providing second-mile capacity at substantial cost savings relative to fiber. We assume that microwave allows high-capacity connectivity at a lower price by bypassing the need for a direct aerial or trench-based connection. For instance, a microwave link can provide speeds of up to 500 Mbps over a distance of 20 miles[58] at a typical equipment cost of roughly $50,000.[59]

By contrast, costs of new fiber construction depend heavily on the distance to an existing fiber network and whether the area has aerial plant available for connection. Costs can range from approximately $11,000 to $24,000 per mile for aerial construction and roughly $25,000 to $165,000 per mile for buried construction.[60] Many providers may prefer fiber regardless of the cost, especially in denser areas, because of its ability to provide higher capacity per link and its inherent reliability.

Overall, when compared with new fiber construction, and even with leased Ethernet links, microwave links can have a lower total cost for link distances greater than 1-2 miles.[61]

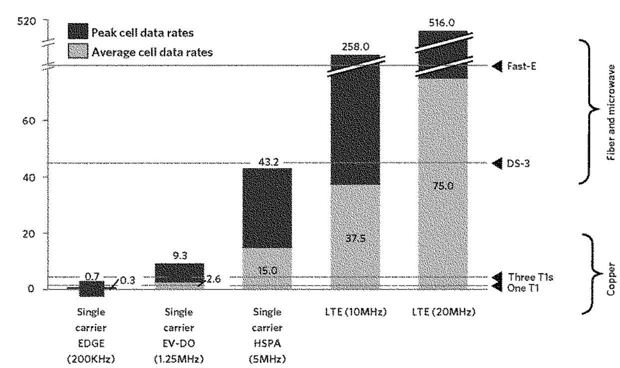
Ethernet over Copper (EoC) may also be part of the 4G-backhaul solution. We did not include EoC in our 4G-backhaul calculations for several reasons: first, as noted above, there is often a limited amount of copper available; second, the quality of that copper over the multi-mile distances in rural areas is unknown; and third, for new cell-site construction, where there are no existing backhaul facilities, carriers are likely to install fiber or rely on microwave.

Hybrid Fiber Microwave (HFM) backhaul architecture

Since microwave can be a cost-effective substitute for fiber, a Hybrid Fiber Microwave (HFM) backhaul architecture would yield significant cost savings in wireless networks relative to an all fiber network (see Exhibit 4-U). Specifically, as illustrated in the exhibit, in an HFM architecture some cell sites rely on microwave for backhaul, and only few cell sites are fiber-fed. The fiber-fed sites serve as backhaul "aggregation points" for the remaining cell sites. These remaining sites connect to the fiber-fed aggregation points using microwave links, sometimes using more than one microwave hop. For example, Cell site 3 is fiber fed, serving as an aggregation point for the backhaul needs of Cell sites 1 and 2. Further, Cell site 2 connects to Cell site 3 using one microwave hop, while Cell site 1 connects using two (via Cell site 2). Such HFM architectures are already being used by wireless service providers such as Clearwire, for example.[62]

Even though the microwave links now have reliability comparable with their wireline counterparts, an HFM network that uses a large number of hops can lead to concerns about

Exhibit 4-T:
Average and Peak Capacity of a 3-Sector Cell Site Relative to Backhaul Speeds, Mbps



reliability. To see this, observe in Exhibit 4-U that the loss of the microwave link between Cell sites 2 and 3 will also result in the loss of backhaul connectivity for Cell site 1. If each of these cell sites had a radius of 5 miles, then as much as 150 square miles would lose coverage through the loss of the single link. Clearly, then, this cascading effect can become particularly pronounced in a network that has a large number of hops. On the other hand, the more hops, the greater the potential for second-mile cost savings.

Our baseline model for FWA uses an HFM architecture with a maximum of four microwave hops.

In unserved areas, an HFM second-mile network architecture has cost advantages over a fiber-only network architecture. Microwave backhaul has two additional benefits, especially to service providers who do not already own fiber middle-mile backhaul assets. First, microwave can often be deployed faster than fiber. Second, in many territories, the owner of wired backhaul facilities could be a competitor in providing wireless service. In such cases, microwave backhaul offers an effective alternative to paying competitors for backhaul service.

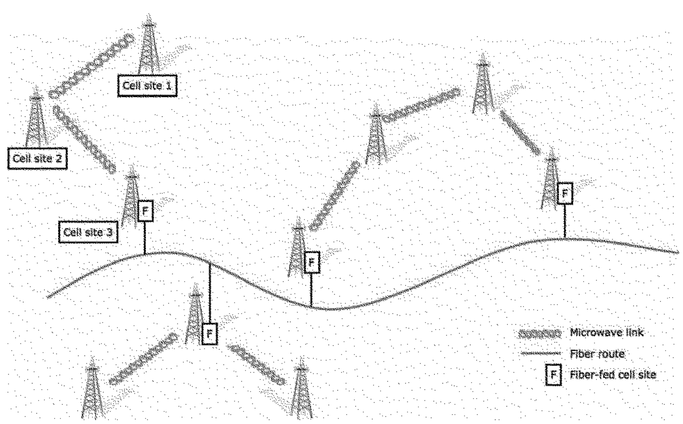
However, microwave backhaul also has two significant limitations. First, as noted earlier, microwave links have capacity limitations and cannot be used for very high-speed backhaul needs. Further, higher data rates require more spectrum. Since there is only a limited amount of spectrum available, carriers can only have a limited number of high-speed microwave links in a geographical area. Note that the NBP had a series of recommendations related to improving point-to-point backhaul solutions in Chapter 5.

The second limitation is a requirement for line of sight from one microwave tower to the next. In hilly or mountainous terrain, this may mean that a provider needs to add additional microwave relays even beyond the reduction in cell size described above, adding to costs. It may be the case that the same terrain issues drive up fiber costs as well, perhaps even more quickly, so this will not necessarily tip the balance toward fiber. But it will likely drive up backhaul costs overall. Further, in some cases the tower may need structural reinforcements to support a microwave antenna, which will drive up the cost of microwave installation.

So, even though an HFM architecture has significant cost advantages, fiber is expected to be the primary backhaul choice for service providers because it offers a scalable, future-proof backhaul solution.

Finally, a fiber-only architecture has one significant strategic advantage. As broadband needs continue to grow, fiber emerges as the only last-mile technology capable of meeting ultra high-speed needs. So, any solution that brings fiber closer to the home by pushing it deeper into the network puts into place an infrastructure that has long-term strategic benefits. On balance, therefore, we need to weigh this strategic benefit against the higher associated cost to evaluate the value of a fiber-only architecture over an HFM architecture.

Exhibit 4-U:
Hybrid Fiber Microwave Backhaul Architecture for Cellular Networks



Economics of a Wireless Network

Exhibit 4-V shows the network elements that we modeled for FWA network cost analysis (see also Exhibit 4-A above). Specifically, in the last mile—the link from the cell site to the end-user—we model installation and operations costs, as appropriate, for the tower infrastructure, Radio Access Network (RAN) and other ancillary[63] equipment. We also account for the cost of the end-user CPE. In the second mile, which is the backhaul connection from the cell site to the second point of aggregation in the exhibit, we model the costs of installing microwave equipment and new fiber, as needed; see the Section on Middle Mile for details on backhaul network architecture.

Our network model, as shown in Exhibit 4-V, shows that the Investment Gap when using FWA networks in the 700MHz band for providing broadband to the unserved population in the United States is $12.9 billion (Exhibit 4-W). This funding gap is for the wireless buildout *only* and is not driven by the second least-expensive of a mix of technologies. For more details on our overall network modeling assumptions and principles, see **Creating the Base-case Scenario and Output** above.

Dependence on terrain type

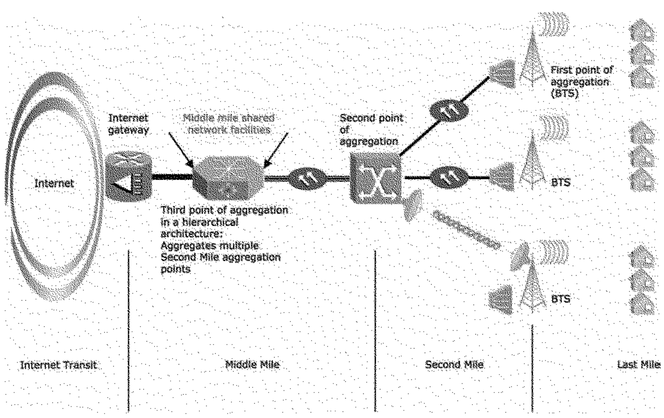
Recall that for our network model, we classify terrain into four types, choosing a different maximum cell radius for each. Exhibit 4-X shows the average investment (i.e. capex) per housing unit (HU) and Investment Gap per HU based on the underlying cell radius required. The smaller cell radii correspond to counties that are mountainous/hilly.

The exhibit shows that the cost of serving HUs in hilly terrain can be as much as 30 times higher on average than in flatter areas. This is in part due to the fact that smaller cell radii in hilly terrain mean that we need more cell sites, thereby driving up the cost; and, in part due to the fact that HU density is also lower in hilly areas. [64]

Our classification of terrain in Exhibit 4-K is based on a statistical analysis of terrain variation data. It is likely that in some instances our method will misclassify a census tract (CT). The only way to get an extremely accurate estimate of cell radius is to actually do a RF propagation analysis for each CT using tools such as those provided by EDX Wireless. That is extremely time-consuming and expensive. To range the impact of misclassification, we analyze the sensitivity of buildout costs and the investment gap to our terrain classification parameters.

Exhibit 4-Y illustrates the results from our sensitivity analysis. In addition to the FWA buildout costs and the FWA investment gap, we also show the overall investment gap for bringing broadband to the unserved using a mix of technologies. Note that the impact on the overall investment gap is less than 10%. This is because the overall investment gap is driven by the second least-expensive technology. More specifically, we find that the percentage of unserved HUs served by wireless drops from 89.9% in the baseline to 89.1% with the "very mountainous" classification in parameter C, thus explaining the relatively small impact terrain classification has on the overall investment gap.

Exhibit 4-V: Illustrative Wireless Network Architecture



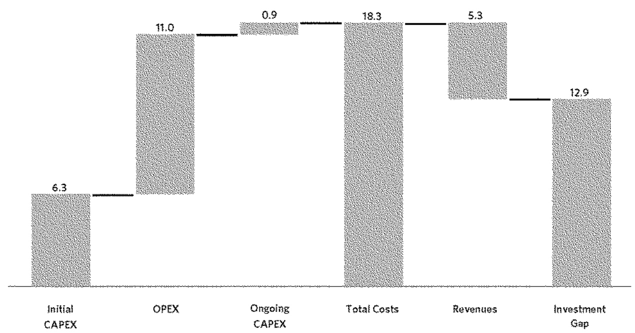
Dependence on downlink capacity

Since LTE is not commercially deployed yet, it is conceivable that actual downlink spectral efficiency and, consequently, subscriber capacity differ from that simulated. So, we analyze the dependence of wireless buildout costs and the investment gap to our subscriber capacity estimates as shown in Exhibit 4-Z. We note that the impact on costs as well as Investment Gap is negligible. Consequently, the impact on the overall Investment Gap—as determined by the cost of the second least-expensive network—is also small (not shown in chart).

Dependence on spectrum

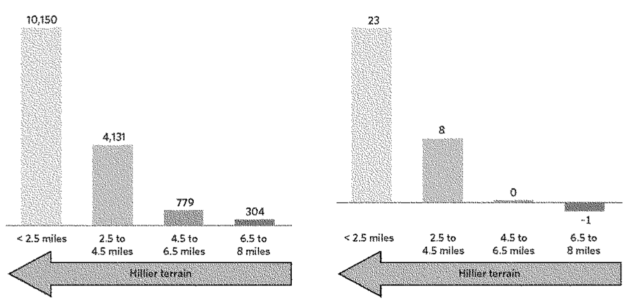
Our baseline model assumes a network deployment in the 700 MHz band. If, instead, we deploy the network in the PCS band, the

Exhibit 4-W:
Investment Gap for Wireless Networks



(in billions of USD, present value)

Exhibit 4-X:
Total Investment per Housing Unit (HU) and Investment Gap per HU by Cell Size



Total initial investment per HU by cell radii

(USD, present value)

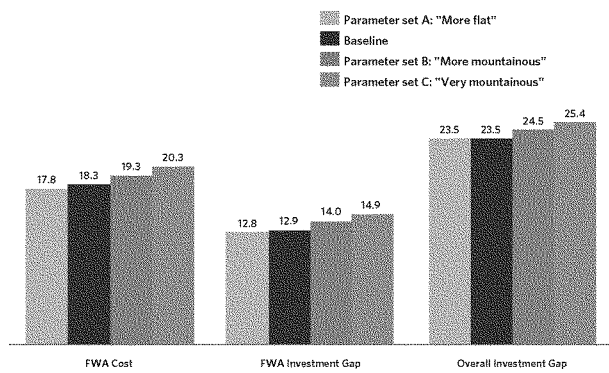
Investment Gap per HU by cell radii

(in thousands of USD, present value)

total cost of the FW deployment in counties with negative NPV is 96% greater. Further, the FW investment gap is 90% more. Note that this is a comparison of the FW investment gap only and not that of the overall investment gap. For this analysis, we use the following maximum cell radius for each of the four terrain types.[65]

Terrain classification	Maximum cell radius (miles)
Flat	5
Rolling hills	3
Hilly and Mountainous	2

Exhibit 4-Y:
Sensitivity of Investment Gap to Terrain Classification—Change in Costs and Investment Gap by Changing Terrain Classification[66]



(in billions of USD, present value)

Terrain type	Classification parameters based on Standard Deviation of elevation of CTs			
	Baseline	Parameter set A	Parameter set B	Parameter set C
Flat	≤ 20	≤ 25	≤ 20	≤ 20
Rolling hills	20 to 125	25 to 125	20 to 125	20 to 125
Hilly	125 to 350	125 to 350	125 to 300	125 to 250
Mountainous	≥ 350	≥ 350	≥ 300	≥ 250

Cost and gap shown for counties that have a negative NPV. The baseline classification is based on parameters in Exhibit 4-K. The remaining parameter sets alter the classification of flat and hilly terrains, as shown below. We highlight the changes in the parameters from the baseline for convenience.

Our baseline also assumes 2x20 MHz of spectrum availability. Exhibit 4-AA shows the economic impact of spectrum availability assumptions. Note that the lack of spectrum increases the cost of the buildout in unserved areas by nearly 5%. The cost impact is relatively small because 2x10 MHz of spectrum is sufficient for 82% of the cell sites (see Exhibit 4-S). The cost impact in areas with negative NPV is even smaller (less than 3%). This is because the cell sites in these areas are typically smaller, so that they also have fewer HUs in them (see Exhibit 4-X for the impact of cell radius on the Investment Gap), which reduces the spectrum needs for the cell sites. Consequently, the impact on the Investment Gap in these areas is also small.

We have not yet addressed the fact that no U.S. service provider currently has more than 2x10MHz of contiguous spectrum in the 700MHz band. But both Verizon Wireless and AT&T Wireless do have noncontiguous spectrum holdings of over 2x20MHz of spectrum across different bands. However, these bands will not all have similar propagation characteristics.

A common deployment strategy used in such situations is to use the lower frequency bands with superior propagation characteristics to serve households further away from the cell site. The higher frequency bands, which can have superior capacity through the use of MIMO techniques, are then reserved for serving those closer to the cell site. This ensures that each available spectrum band is efficiently used.

Cost per cell site

Exhibit 4-AB shows a cost breakdown of a wireless network for all unserved areas. Note that the cost of the network is dominated by last-mile and second-mile costs, which we shall refer

Exhibit 4-Z: Sensitivity of Costs and Investment Gap to Subscriber Capacity Assumptions—Change in Costs and Investment Gap Under Different Downlink Capacity Assumptions

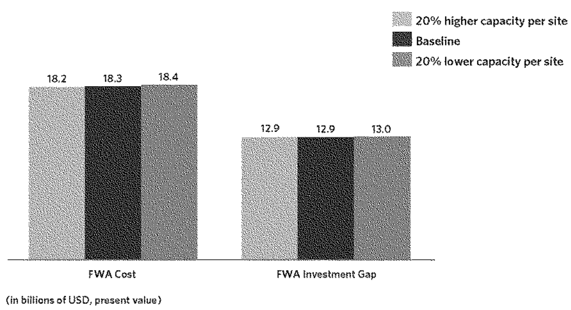
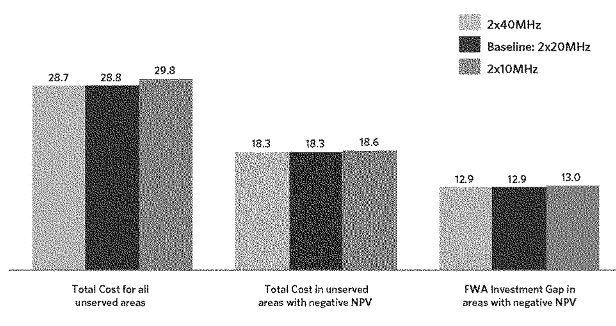


Exhibit 4-AA: Impact of Spectrum Availability on FWA Economics—Change in FWA Costs and Investment Gap Under Different Spectrum Availability Assumptions



to as simply *site costs*; these account for more than 67% of the total costs. Exhibit 4-AC shows that tower construction/lease and second-mile backhaul costs constitute 68% of the cost of deploying, operating and maintaining a cell site.

Tower construction/lease costs comprise 34% of site costs. To model site costs appropriately, we create one set of hexagonal cells that cover the entire country for each analyzed cell-size (2, 3, 5 and 8 miles). These hexagonal cells represent the wireless cells. Each cell needs to contain at least one tower. To account for the fact that existing services imply existing towers, we turn to several data sources. First, we used the Tower Maps data set of tower locations.[67] For cells that do not include a tower site in that data set, we used 2G and 3G coverage as a likely indicator of cell site availability. Specifically, we assumed that the likelihood of a tower's presence is half the 2G/3G coverage in the hexagonal cell area. For example, a cell that is fully covered by 2G/3G service has only a 50% chance of having a tower site. In areas without a tower, we assume that a new tower needs to be constructed 52.5% of the time;[68] the remainder of the time we assume a cell site can be located on an existing structure (e.g., a grain silo or a church steeple).

In practice, the cost of deploying a wireless network in an area without any wireless coverage today should be higher because of the likely absence of any existing wireless network infrastructure that the provider can leverage. And, with our assumptions above, we capture that effect.

Our cost assumptions in the model indicate that the total 20-year cost of constructing and maintaining a tower is $350K to $450K. By comparison, the total cost of co-locating on an existing structure is only $165K to $250K. Further, our model

Exhibit 4-AB: Cost Breakdown of Wireless Network Over 20 Years[69]

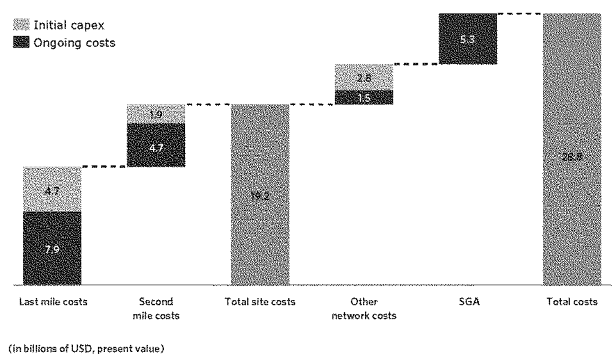
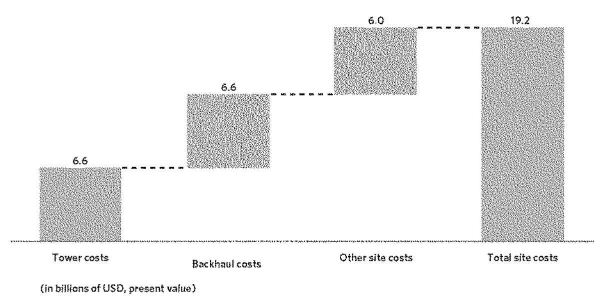


Exhibit 4-AC: Breakdown of Total Site Costs for Wireless Network in Unserved Areas



shows that new tower construction is necessary around 15% of the time.

Second-mile backhaul

Our baseline model for the FWA network uses a Hybrid Fiber Microwave (HFM) backhaul architecture with limited microwave penetration. Specifically, we allow a maximum of four hops. Recall that a network architecture that allows a deeper microwave penetration will reduce network costs at the expense of a possible reduction in reliability. Recognizing this trade-off between reliability and cost, we analyze how a restriction on the number of hops affects the cost of the FW buildout and the investment gap. Specifically, we analyze two HFM architectures and compare them with a fiber-only network: (1) Very limited microwave penetration: an HFM network where we allow a maximum of four hops; and (2) Moderate microwave penetration: an HFM network where we allow a maximum of four hops.

In each scenario, we constrained the capacity of the microwave link to 300 Mbps. That limits our ability to daisy-chain microwave links, because the cumulative backhaul needs of all cell sites upstream of a link in the chain cannot exceed the capacity of that link. For example, returning to Exhibit 4-U, the capacity of the link between Cell sites 2 and 3 must be greater than the cumulative backhaul needs of Cell sites 1 and 2; otherwise, one of Cell sites 1 or 2 will require a fiber connection.

Exhibit 4-AD compares the initial investment for the three scenarios. We note that the cost of limiting the number of hops is small—less than 5% when we limit it to two instead of four. This is because most of the unserved regions do not constitute large contiguous areas and can, therefore, be served using a small cluster of cell sites. As a result, the limitation does not severely impact cost. In fact, in the scenario where we allow deep microwave penetration, more than 85% of the cell sites using microwave backhaul connect to a fiber-fed cell site in two or fewer hops.

Exhibit 4-AD: Cost of an HFM Second-Mile Backhaul Architecture—Initial Investment with Different Second-Mile Backhaul Network Architectures

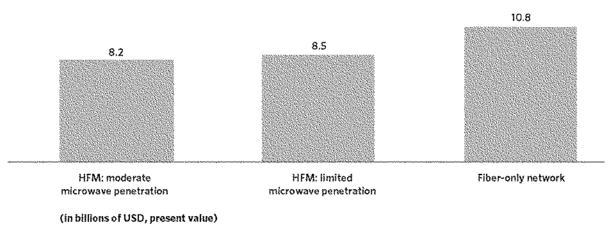


Exhibit 4-AE: Cost Assumptions and Data Sources for Wireless Modeling

Parameter	Source and comments
Tower construction	Mobile Satellite Ventures filing under Protective Order
BTS	Mobile Satellite Ventures filing under Protective Order
Ancillary Radio Access Network	Mobile Satellite Ventures filing under Protective Order
Core network equipment	Mobile Satellite Ventures filing under Protective Order
Site operations	Mobile Satellite Ventures filing under Protective Order
Land Cover	http://www.landcover.org/data/landcover/ (last accessed Feb. 2010) Summary File 1, US Census 2000
Elevation	NOAA GLOBE system http://www.ngdc.noaa.gov/mgg/topo/gltiles.html (last accessed Feb. 2010)
Microwave radio	Dragonwave
Microwave operations	Level-(3) filing under Protective Order
Fiber installation, equipment, operations and maintenance	See cost assumptions for FTTP
Wireless CPE	Based on online price information available for different manufacturers

Conclusions

In order to engineer a wireless network to provide a service consistent with the National Broadband Availability Target, we use the uplink speed target and supplement it with terrain data to compute a maximum cell radius for four different terrain types. In the downlink, we calculate a maximum subscriber capacity per cell site.

A significant driver of variation in per site costs is tower availability and backhaul costs. For backhaul, a Hybrid Fiber Microwave (HFM) architecture results in a lower cost; but a fiber-only network does have the benefit of deeper fiber penetration.

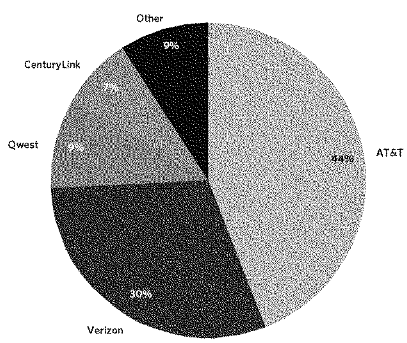
Next, we conduct a sensitivity analysis of our model parameters and assumptions. Not surprisingly, spectrum availability and spectrum bands can have a significant impact on the cost the FWA network as well as the investment gap.

12,000-foot-loop DSL (Digital Subscriber Line)

Telephone networks have traditionally been two-way (or duplex) networks, arranged in a hub-and-spoke architecture and designed to let users make and receive telephone calls. Telephone networks are ubiquitous in rural areas, in part because local carriers have had the obligation to serve all households in their geographic area; this is known as the carrier-of-last-resort obligation. In addition, some telephone companies have historically relied upon implicit subsidies at both the federal and state levels to provide phone service. More recently, they have received explicit financial support through the federal Universal Service Fund (USF). The USF was designed to ensure that all households have access to telephone service at rates that are reasonably comparable to urban rates.

Thousands of independent telephone companies provided service in local markets. But when the telephone network was originally constructed, a single operator, AT&T, dominated it. In 1984, AT&T divested its access network into seven Regional Bell Operating Companies (RBOCs). Over time, the original seven RBOCs have consolidated into three: AT&T (formerly Southwestern Bell, Pacific Telesis, Ameritech, BellSouth and non-RBOC SNET), Verizon (formerly NYNEX, Bell Atlantic and non-RBOC GTE) and Qwest (formerly US WEST).

Exhibit 4-AF:
Breakout of Voice Line Ownership — Telco Consumer Telephone Access Lines Market Share (3Q 2009)[70]



Percent of United States lines

Numbers do not sum to 100% due to rounding.

Consolidation has occurred among smaller Incumbent Local Exchange Carriers (ILECs) as well, with many of them consolidating into CenturyLink, Windstream, Frontier and Fairpoint. Yet well over a thousand small ILECs remain. Today, there are more than 1,311 Telco operators,[71] but the three RBOCs own 83% of voice lines.[72] See Exhibit 4-AF.

The evolution of modern telephone company networks has required significant investments in network capabilities in order to offer broadband access. In the late 19th and early 20th centuries, these networks were built for plain old telephone service (POTS), which provides basic voice service between users over twisted-pair copper wires. These wires, or "loops," were installed between the home and the telephone exchange office via an underground conduit or telephone poles. The basic telephone network architecture and service, originally designed for two-way, low frequency (~4 kilohertz, or kHz), all-analog transmissions with just enough capacity to carry a single voice conversation, are still used today by most homes and businesses. In fact, this network is the basis for the high-speed broadband service known as Digital Subscriber Line (DSL) offered by telecommunications companies.

With the advent of the modem, telephone networks were the first networks to provide Internet access. After all, millions of homes were already "wired" with twisted-pair copper lines that provided POTS. Initially, dial-up Internet used the same analog network designed for voice to deliver Internet access at speeds of up to 56 kilobits-per-second (kbps). To offer high-speed access, the network needed to be reengineered to handle digital communications signals and upgraded to handle the tremendous capacity needed for broadband data and broadcast transmissions. Although twisted-pair copper cables are capable of carrying high-capacity digital signals, the network was not optimized to do so. The large distance between a typical home and telephone exchange offices, as well as the lack of high-speed digital electronics, stood in the way of broadband deployments.

Steps to upgrade telephone networks for broadband:

- Invest in fiber optic cable and optic/electronics to replace and upgrade large portions of the copper facilities for capacity purposes
- Replace and redesign copper distribution architecture within communities to "shorten" the copper loops between homes and telephone exchanges
- Deploy new equipment in the exchanges as well as the homes (DSL equipment) to support the high capacity demands of DSL and broadband
- Develop the technology and equipment necessary for sophisticated network management and control systems

- Implement back-office, billing and customer service platforms necessary to provide the services common among telephone operators today

DSL provided over loops of 12,000 feet (12 kft) is a cost-effective solution for providing broadband services in low-density areas. In fact, it is the lowest cost solution for 10% of the unserved housing units. DSL over 12 kft loops meets the broadband target of a minimum speed threshold of 4 Mbps downstream and 1 Mbps upstream, and the backhaul can easily be dimensioned to meet the BHOL per user of 160 kbps.[73] Since DSL is deployed over the same existing twisted-pair copper network used to deliver telephone service, it benefits from sunk costs incurred when first deploying the telephone network.

Capabilities

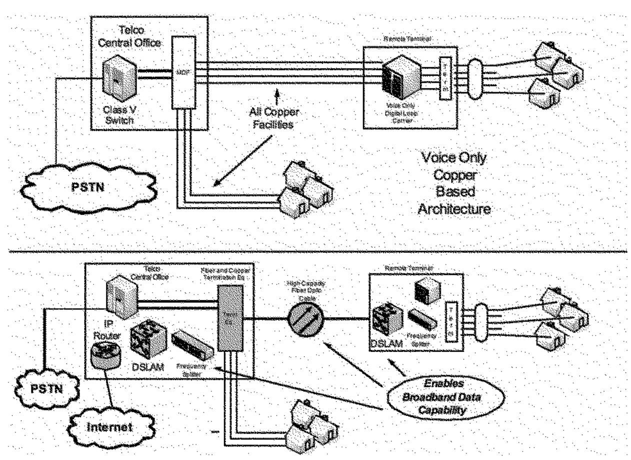
DSL over loops of 12,000 feet typically uses ADSL2/ADSL2+ technology, which was first standardized in 2005 and which uses frequencies up to 2.2 MHz. As ADSL2+ over 24AWG gauge wire provides rates of 6 Mbps downstream and 1 Mbps upstream, the technology meets the speed requirements for broadband service of 4 Mbps down and 1 Mbps up. Figure 4-AH illustrates how loop length affects speed for ADSL2+.

The technology can perform 1 Mbps upstream on 12 kft of 24 AWG twisted-pair copper loops.[74] In this case, 24 AWG wire is assumed with no bridged taps. Performance with 22 AWG wire, which is often used in rural areas, would yield higher bitrates, while use of 26 AWG wire would yield lower rates.

In order to provide faster speeds than those listed above, DSL operators can bond loops and continue to shorten loop lengths. The bonding of loops can be used to multiply the speeds by the number of loops to deliver rates over 30 Mbps if sufficient numbers of copper loops are available.[75] The performance improvements that can be achieved by shortening loops from 12 kft to 5,000 feet or 3,000 feet and replacing existing technology with VDSL2 are discussed in the DSL 3-5 kft section below. Shortening loops requires driving fiber closer to the end-user; while costly, it could provide much faster speeds that could serve as an interim step for future fiber-to-the-premises (FTTP) deployments. Investment in 12 kft DSL, therefore, provides a path to future upgrades, whether the upgrade is to 5 kft or 3 kft loops or FTTP.

For the small-to-medium enterprise business community, copper remains a critical component in the delivery of broadband. Ethernet over Copper (EoC), often based on the G.SHDL standard, is a technology that makes use of existing copper facilities by bonding multiple copper pairs electronically. EoC can provide speeds between 5.7 Mbps on a single copper pair

Exhibit 4-AG: Telco-Plant Upgrades to Support Broadband



and scale up to 45 Mbps, or potentially higher, by bonding multiple copper pairs. Though middle and second mile connectivity of 100 Mbps is likely necessary, bonded EoC technology can serve as a useful and cost-effective bridge in many areas. Moreover, the embedded base of copper plant is vast—one market study shows that more than 86% of businesses today are still served by copper.[76] Although service providers may prefer to deploy fiber for new builds, existing copper likely will be part of the overall broadband solution, particularly for last- and second-mile applications, for the next several years.

In addition to bonding and loop shortening, marginal speed improvements and increased stability of service levels with ADSL2+ can be achieved through the use of Level 1 dynamic spectrum management (DSM-1).[77] DSM-1 is physical layer network management software that enables reliable fault diagnosis on DSL service. This advancement is available today and may increase bit-rates by up to 10% on ADSL2+.[78] Additionally, DSM-1 helps to ensure stability and consistency of service such that carriers can reach the theoretical 4 Mbps even at high take rates within a copper-wire binder.

We model a 12 kft DSL network that meets the speed and capacity requirements defined in the discussion of 4Mbps downstream requirement in Chapter 3. As outlined in the network design considerations below, we note network sharing in DSL networks does not start until the second mile. The modeled ADSL2+ technology exceeds the speed requirement and includes costs associated with loop conditioning when appropriate. In addition, the modeled build ensures that second and middle-mile aggregation points are connected to the Internet backbone with fiber that can support capacity requirements.

A fundamental operational principle for DSL is that all of the bandwidth provisioned on the last-mile connection for a given end-user is dedicated to that end-user. Unlike HFC, Fixed Wireless, and PON, where the RF spectrum is shared among multiple users of that spectrum and thus subject to contention among them, the last-mile DSL frequency modulated onto the dedicated copper loop and associated bandwidth are dedicated. Sharing or contention with other users on the network does not occur until closer toward the core of the network, in the second and middle mile, where traffic is aggregated (see Exhibit 4-AI). This second- and middle-mile network sharing still occurs in all other access network technologies as well. The "sharing" concept is introduced in detail in the capacity planning discussion in the Network Dimensioning section below.

The ADSL 2+ standard is widely deployed today in telco DSL networks and is assumed to be the minimum required to achieve 4 Mbps downstream and 1 Mbps upstream. The last mile access network ADSL2+ is defined in ITU-T Recommendation G.992.5[11]. The technology provides rates of 6 Mbps downstream and 1 Mbps upstream on the longest loops of a Carrier Serving Area (CSA) (3.7 km or 12 kft of 24 AWG twisted-pair copper loop), with much higher rates attainable on shorter loops.[79]

We perform our analysis and cost calculations based upon a maximum 12 kft properly conditioned copper loop. Loop conditioning costs are applied to those loops that have never been conditioned to offer DSL. For example, if the statistical model showed any DSL speeds for a given census block, we do not apply the loop-conditioning cost since we assume it had already occurred. We believe that only about 1 million homes nationwide have DSL available at a speed below the 4 Mbps

Exhibit 4-AH: Downstream Speed of a Single ADSL2+ Line as a Function of Loop Length[80] (24 AWG)

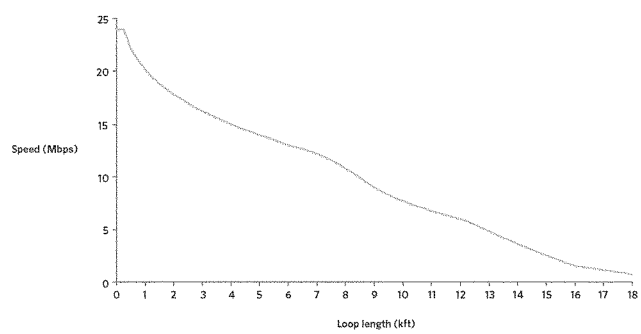


Exhibit 4-AI: DSL Network Diagram

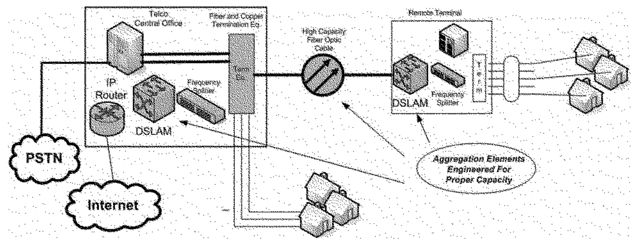
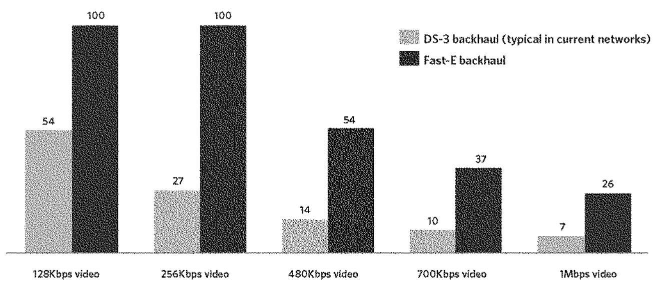
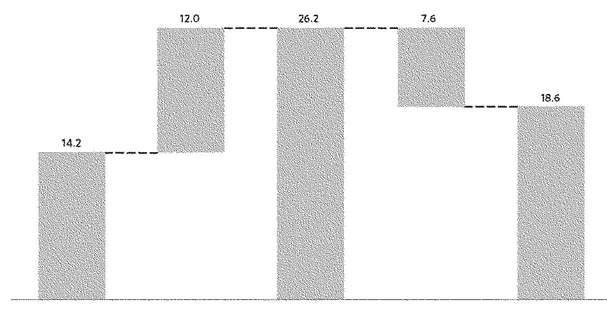


Exhibit 4-AJ: Capacity of a DSL Network – Simultaneous Streams of Video in a DSL Network[81,82]



Percent of subscribers, 100% = 384

Exhibit 4-AK: Economic Breakdown of 12,000-foot DSL



(In billions of USD, present value)

target speed. In the remaining areas, comprising about 6 million housing units, the model includes loop-conditioning costs.

We model the ADSL2+ access network such that DSLAMs are connected to the central office and other middle- and second-mile aggregation points using fiber optic-based Ethernet technology that provides backhaul capacities more than sufficient to meet a 4 Mbps down and 1 Mbps up end-user requirement. Moreover, we calculate the estimated average BHOL per user to be 160 kbps. A typical DSLAM serves between 24-384 subscribers. Since Ethernet-based backhaul provides a minimum of 100 Mbps (a.k.a. Fast-E) bandwidth, scaling to as much as 1 Gbps (a.k.a. Gig-E), the middle- or second-mile aggregation point has sufficient backhaul capacity required to support 4 Mbps down and 1 Mbps up. The resulting capacity of such a DSL network dimensioned with a Fast-E backhaul is shown in Exhibit 4-AJ.

In a DSL network with fewer subscribers, as will be the case in rural areas with low population density, the fraction of users who could simultaneously enjoy video streams of a given data rate would go up proportionately. The dimensioning discussed above is in contrast to the capacity of the network with conventional backhaul provisioning of ~1 Mbps in the shared portions of the network for every 14.5 users.[83]

Economics

The economics of the DSL network depend on revenues, operating costs and capital expenditures. Using granular cost data from DSL operators and vendors, the model calculates the gap to deploy 12 kft DSL to unserved markets as $18.6 billion. Exhibit 4-AK shows the breakout among initial capital expenditure, ongoing costs and revenue.

Initial Capex

Initial capital expenditures include material and installation costs for the following: telco modem, NID, protection, aerial or buried copper drop, DSLAM, cabinet, ADSL2+ line card,

Exhibit 4-AL: Data Sources for DSL Modeling

Material Costs	Source
Telco Modem	Windstream filing under Protective Order
For port sizes of 24 - 1,008:	
DSLAM Unit	Windstream filing under Protective Order
Cabinet	Windstream filing under Protective Order
Allocated Aggregation Cost (CO Ear)	Windstream filing under Protective Order
ADSL2+ line cards	Windstream filing under Protective Order
Fiber optic cabling	FTTH Council
Aerial Drop	Windstream filing under Protective Order
Buried Drop	Windstream filing under Protective Order
NID	Windstream filing under Protective Order
Protection	Windstream filing under Protective Order
Copper cable (24 and 22 AWG)	Windstream filing under Protective Order
Drop terminal/ building terminal (DTBT)	Windstream filing under Protective Order
Feeder distribution interface (FDI)	Windstream filing under Protective Order
Material Labor Costs	
FDI Splicing and Placing labor cost	Windstream filing under Protective Order
DTBT Splicing and Placing labor cost	Windstream filing under Protective Order
Telco Drop and NID labor cost	Windstream filing under Protective Order
Structure Labor Costs	
Duct, Innerduct and Manhole labor cost	Windstream filing under Protective Order
Loop Conditioning cost	Windstream filing under Protective Order
Poles, Anchor and Guy labor cost	Windstream filing under Protective Order
Buried Excavation labor cost under various types of terrain- normal, hardrock and softrock	Windstream filing under Protective Order

allocated aggregation cost, fiber cable up to 12 kft from the end-user, feeder distribution interface and drop terminal/building terminal, as well as the engineering costs for planning the network and the conditioning required on loops (i.e., the removal of load coils[84] and bridged taps[85]). For a detailed list of inputs into our model and the source for each, please refer to Exhibit 4-AL.

Ongoing Costs

Ongoing costs include: replacement capital expenditures required to replace network components at the end of their useful lives, network administration, network operations center support, service provisioning, field support, marketing and SG&A.

Revenues

Revenues are calculated by taking the Average Revenue Per User (ARPU)—which varies according to the level of broadband service/speed provided as well as whether the bundle of services provided includes voice, data and video—and multiplying it by the average number of users. For 12 kft DSL, only data ARPUs are used as incremental to voice, which is assumed present due to the fact that DSL technology utilizes twisted-pair copper wires originally installed and used for POTS.

Satellite

Broadband-over-satellite is a cost-effective solution for providing broadband services in low-density areas. In fact, it could reduce by $14 billion the gap to deploy to the unserved if the 250,000 most-expensive-to-reach housing units were served by satellite broadband. Satellite broadband, as provided by next generation satellites that will be launched as early as 2011, meets our Broadband Availability Target requirements by offering a minimum speed threshold of 4 Mbps downstream and 1 Mbps upstream and BHOL per user of 160 kbps.

Capabilities

Satellite operators are in the midst of building high capacity satellites that will dramatically augment the capacity available for subscribers in the next two years. ViaSat and Hughes, for example, plan to launch high-throughput satellites in 2011 and 2012, and offer 2-10 Mbps and 5-25 Mbps download-speed services, respectively. Upload speeds will likely be greater than the 256 kbps offered today, but no specific upload speeds have been announced. Since satellites are technically constrained by the total capacity of the satellite (>100Gbps), operators could change plans to offer customers at least 1 Mbps upstream even if it is not currently planned. Since the next-generation satellites will be able to offer 4 Mbps downstream and 1 Mbps upstream, satellite broadband meets the technological requirements for inclusion in the National Broadband Plan.

Technical limitations

Over the last decade, satellite technology has advanced to overcome some of the common drawbacks previously associated with it. Due to the properties of the spectrum band used for this service (Ku band downlink 11.7-12.7 GHz, uplink 14-14.5 GHz; Ka band downlink 18.3- 20.2 GHz; uplink 27.5-31 GHz), inclement weather can have an effect on service. However, the ability to dynamically adjust signal power, modulation techniques and forward error correction have all reduced degradation of service except in the most severe of weather conditions.

Since the satellites are in geosynchronous orbit nearly 22,300 miles above the earth, there is a round-trip propagation delay of 560 milliseconds associated with a typical PING (user to ISP and back to user). Recently, integrated application acceleration techniques, including TCP acceleration, fast-start and pre-fetch, have helped mitigate satellite latency for some Web-browsing experiences.[86]

Despite these technological advancements to improve the Web-browsing experience, the latency associated with satellite would affect the perceived performance of applications requiring real-time user input, such as VoIP and interactive gaming. Not only does this delay have a potentially noticeable effect on applications like VoIP, but it would also be doubled in cases where both users were using satellite broadband (e.g., if two neighbors, both served by satellite VOIP, talked on the telephone). Given that most voice calls are local, this could become a significant issue for rural areas if all calls must be completed over satellite broadband.

Spot beams

Broadband satellites use multiple spot beams to provide nationwide coverage. Spot beams use the same spectrum over and over in different geographies, providing more total throughput for a given amount of spectrum. The multiple re-use of frequencies across the coverage area for a satellite provider is similar to a cellular system that reuses frequencies in a "cell." Furthermore, because a spot beam focuses all its energy on a very specific area, it makes more efficient use of the available satellite power.

Nevertheless, a satellite's bandwidth to an end user is provided by and limited to the bandwidth of the spot beam covering that geographic area as well as the total satellite capacity. Therefore, potential network chokepoints for a satellite broadband network include total satellite capacity and spot beam bandwidth.[87] Each spot beam is designated over a section of the United States; once a spot beam is assigned to a certain geographic area, it generally cannot be re-allocated, shifted or moved to cover another area.

With its first leased satellite in 2005 and again with its own satellite in 2007, WildBlue found itself running out of capacity in high-demand regions.[88] In fact, ViaSat plans to aim bandwidth at exactly the same regions where WildBlue's capacity has run out.[89] Many unserved do not live in high-demand areas. These are among the factors that play a role in the capacity assumed available for broadband as discussed below.

Capacity

Providing sufficient capacity for a large number of broadband subscribers, e.g. all of the unserved, may prove challenging with satellite broadband. ViaSat and Hughes believe these next generation satellites have the capacity to serve as many as 2 million homes each;[90] ViaSat has stated on the record that its ViaSat-1 satellite will be capable of providing approximately 1 million households with Internet access service at download speeds of 4 Mbps and upload speeds of 1 Mbps.[91]

Treating satellite as a substitute for terrestrial service, however, requires that satellite be able to deliver service comparable to terrestrial options. Practically speaking, that means that satellite needs to support an equivalent BHOL per user.[92] We believe that the satellite industry could support more than 1.4 million subscribers in 2011 (note that this combines existing capacity with what is planned on being launched) and a total of more than 2.0 million subscribers in 2012 (after the launch of Hughes's next generation satellite, Jupiter). The picture becomes less clear, however, as we look to 2015, when the number of subscribers that current and planned satellites can support would decrease as demand per user grows. End-user demand has been growing at rates as high as 30% annually.[93]

We make certain assumptions in quantifying the number of subscribers that the entire U.S. satellite broadband industry could support with the launch of ViaSat-1 in 2011 and Jupiter in 2012. As there have been no commitments to launch new broadband satellites after 2012, we create a five-year outlook on satellite broadband capacity based on the following assumptions (see Exhibit 4-AM):

- ViaSat will launch a 130 Gbps satellite in early 2011.[94] A comparable satellite, Jupiter, will be launched by Hughes in 2012.[95]
- "Total Downstream Capacity" is 60% of "Total Capacity."
- "Total Usable Downstream Capacity" factors in 10% loss, which includes factors such as utilization and a potential loss of capacity from geographic clustering in which a non-uniform distribution of subscribers would engender certain spot beams to not be fully utilized.

Busy hour offered load (BHOL) assumption

Busy hour offered load, or BHOL, is the average demand for network capacity across all subscribers on the network during the busiest hours of the network. Understanding BHOL is critical for dimensioning the network to reduce network congestion. A more detailed discussion on BHOL can be found later in the Network Requirements section, but the basis for our assumption in satellite is explained here.

Suppose we want to dimension a network that will continue to deliver 4 Mbps. In order to estimate the BHOL for such a network in the future, we first note that average monthly usage is doubling roughly every three years, based on historical growth.[96] There is a significant difference between average usage and the typical user's usage with average usage heavily influenced by extremely high bandwidth users. Next, it becomes crucial to pick the right starting point (i.e., today's BHOL). As the mean user on terrestrial based services is downloading roughly 10 GB of data per month, busy hour loads per user for terrestrial networks translate to 111 kbps busy hour load, assuming that 15% of traffic is downloaded during the busy hour. Terrestrial-based services like cable and DSL experiencing busy hour loads of close to 111 kbps today form the "high usage" case in Exhibit 4-AN.

If we exclude the extremely high-bandwidth users, the average user downloads about 3.5 GB/month, which under the same assumptions for the busy hour would translate to 39 kbps busy hour load. The "medium usage" case in Exhibit 4-AN takes the 39 kbps as a starting point and grows to 160 kbps in 2015; it is this case that we use for our analysis of satellite as well as other networks. The "low usage" case assumes a user downloads 1 GB/month, which translates to 11 kbps; that is roughly what level of service satellite providers offer today of 5-10 kbps.[97] Using 11 kbps as a starting point, the "low usage" case applies the same growth rate as the medium and high usage cases. Exhibit 4-AN summarizes the three usage cases.

Exhibit 4-AM:
Available Satellite Capacity Through 2015

Year	2009	2010	2011	2012	2013	2014	2015
Total Capacity (Gbps)	35	35	165	295	295	295	295
Total Downstream Capacity (Gbps)	21	21	99	177	177	177	177
Total Usable Downstream Capacity (Gbps)	19	19	89	159	159	159	159

One reason why the BHOL-per-user might be lower for satellite: satellite operators' fair access policies, which are essentially usage caps, and a degree of self-selection in those who choose satellite-based broadband. However, in a world where users do not self-select into satellite, it is far from certain the extent to which these reasons will still be valid.

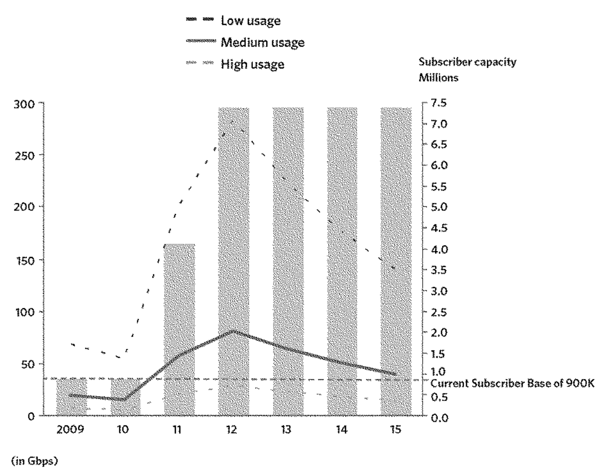
Using the above-mentioned assumptions under the "medium usage" case, the satellite industry could support nearly 1 million subscribers by 2015 (see Exhibit 4-AO). Note that each successive year, the satellites can support fewer subscribers due to the doubling of the BHOL every few years noted above. Each next-generation satellite can support approximately 440,000 subscribers using the usage forecast for 2015. Given that the satellite industry in the United States currently supports roughly 900,000 subscribers, this presents a potential difficulty in meeting the needs of the industry's current subscriber base, plus new net additions. If satellite broadband is offered at a level of service comparable to that of terrestrial broadband under the "medium usage" case and BHOL growth continues, satellite providers will need to devote significant incremental capacity to their existing customer base.

Since satellite providers today offer BHOL of between 5 kbps and 10 kbps,[98] our terrestrial-based BHOL assumptions would represent a marked increase in the service level of satellite providers. ViaSat has said on the record that its ViaSat-1 will support a "provisioned bandwidth" (a concept very similar to busy hour load) of 30-50 kbps.[99] However, satellite operators may not be planning for yearly growth comparable to historical terrestrial rates. Thus, despite the growth in satellite capacity between 2010 and 2012, the number of subscribers capable

Exhibit 4-AN: Satellite Usage Scenarios[100]

Year	2009	2010	2011	2012	2013	2014	2015
Busy Hour Load (Kbps) @ 27% growth y-o-y							
Low usage	11	14	18	22	28	36	46
Medium usage	39	49	62	79	100	126	160
High usage	111	141	178	225	285	360	455

Exhibit 4-AO: Satellite Capacity Based on Low, Medium and High Usage Scenarios



of being supported with our assumptions starts to fall quickly after 2012, absent additional satellite launches. Due to the limited capacity, we do not assume satellite in the calculation of the gap figure of $23.5 billion, but we have contemplated a case in which 250,000 of today's unserved subscribe to broadband over satellite.[101]

If satellite is used to serve the most expensive 250,000 of the unserved housing units, it will reduce the gap. Some 250,000 housing units represent 3.5% of all unserved, <0.2% of all U.S. households, and account for 57%, or $13.4 billion, of the total gap. Exhibit 4-AP shows the remaining gap if satellite is used to serve the most expensive census blocks containing a total of 250,000 subscribers.

The map in Exhibit 4-AQ identifies the location of the highest gap census blocks with a total of 250,000 housing units that we assume are served by satellite in Exhibit 4-AP.

Economics

Nearly all of the costs for satellite broadband are fixed and upfront with the development, construction and launch of the satellite. Each next-generation satellite costs approximately $400 million, which includes satellite construction, launch insurance and related gateway infrastructure.[102] Operating costs for a satellite broadband operator are typically lower than for a wired network provider. Because a single satellite can provide coverage for the entire country with the exception of homes on the north face of mountains or with dense tree cover, the cost of satellite broadband remains constant regardless of household density, which makes it a great option for remote areas.

However, due to the capacity constraints of each satellite, and the growth in use discussed above, satellite operators likely need to continue adding new satellites over time. Estimates of the initial capital expenditure to provide all 7 million of the unserved housing units using satellite broadband service are near $10 billion, including the cost of up to 16 next-generation satellites as well as the CPE and installation for each end-user, assuming the "medium usage" scenario. Timing may be an issue if satellite broadband were deployed as the only means of reaching the unserved, as a next-generation satellite takes approximately three years to build.[103]

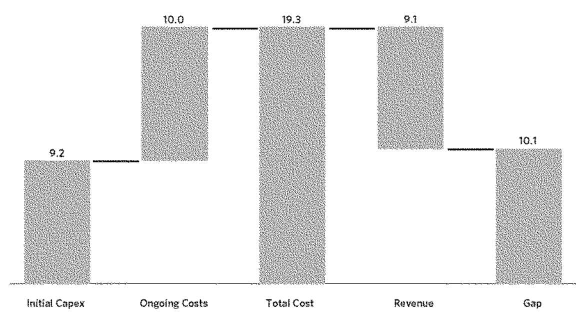
Additionally, with each satellite capable of supporting roughly 440,000 subscribers using our assumptions, satellite operators could be forced to potentially more than double their current monthly subscriber fees, which today range from $60-80 per month, in order to maintain the same return on investment as today.

The cost-per-subscriber is driven by the high up-front costs associated with building and launching a satellite. As capacity required per-subscriber increases, the number of subscribers that each satellite can support drops. That drop, in turn, means that there are fewer subscribers over whom to amortize high fixed costs. Thus the average cost-per-subscriber increases, creating less favorable economics over time or requiring higher monthly fees to be charged to the end-user as described above.

Even with greater efficiency of planned satellites like ViaSat-1 or Jupiter, which provide more capacity per launch, the average capex-per-subscriber will only grow with the increase in effective load-per-user. See Exhibit 4-AR, which shows the average capex per subscriber at various levels of monthly usage. The levels of usage correspond to the low, medium and high usage cases described above.

In Exhibit 4-AR, the capex of a satellite (including build, launch and insurance), the associated gateway infrastructure and the CPE is divided by the number of subscribers, depending on the usage characteristics. Note that the average cost calculation may in fact overstate the true cost of a given subscriber over the lifetime of the satellite.

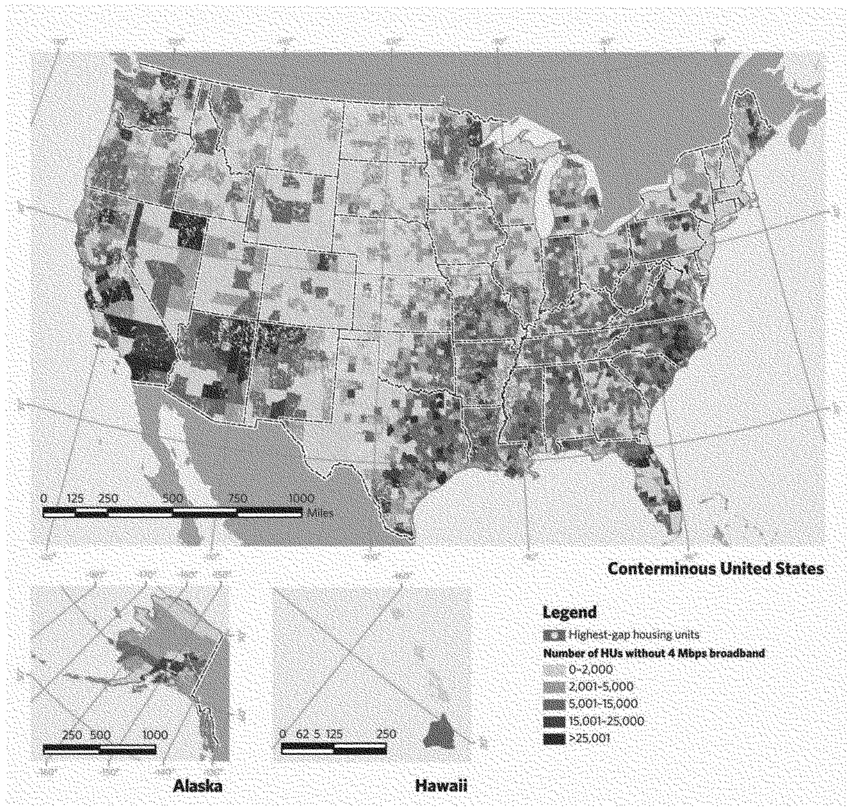
Exhibit 4-AP: Economics of Terrestrially Served if Most Expensive Housing Units are Served with Satellite[104]



Buy down

Due to the relatively high price of satellite broadband service, there may be a need for a subsidy of the monthly ARPU for those served by satellite broadband. Current ARPU for satellite broadband is generally $60-80 per month depending on speed tier, service provider and choice of whether to purchase CPE upfront or pay a monthly fee for it.[105] For illustrative purposes, assuming a starting point of $70 per month, end-user support to reduce the price to $35 monthly would cost $105 million annually (250,000 people x $35 difference in ARPU x 12 months).

Exhibit 4-AQ:
Location of Highest-Gap Housing Units

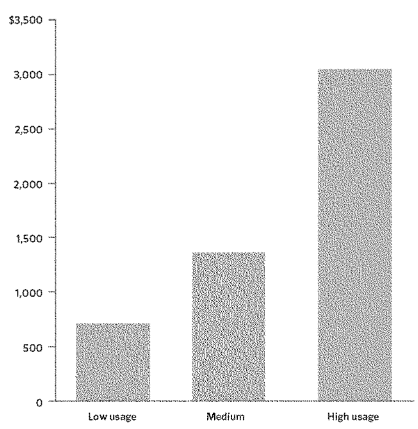


Over 20 years, discounting at 11.25%, the present value of this annual amount is over $800 million.

As discussed above, if satellite operators were to assume a higher use case to provide a level of service comparable to terrestrial providers and to double their price to ensure consistent return on investment (note that the ability to generate enough cash flow affects their ability to finance future satellites), the required subsidy would grow proportionately. Assuming a contemplated starting price of $120, the subsidy required would be $255 million annually (250,000 people x $85 difference in ARPU x 12 months) to yield an end-user price of $35. Over 20 years, the present value of this annual expenditure is roughly $2 billion.

Despite these challenges, we believe that satellite can still provide an economically attractive service for some, and that satellite providers can be an alternative to terrestrial providers, both wired and wireless. However, as we explain further in Chapter 3, uncertainty—principally about the optimal role satellite might play in the disbursement process—has led us to not explicitly include satellite in the base-case calculation.

Exhibit 4-AR:
Satellite Capex per Subscriber— Average cost/POP at Scale



TECHNOLOGIES NOT INCLUDED IN THE BASE CASE

Fiber-to-the-premises (FTTP)

Fiber-to-the-premises (FTTP) offers the greatest potential capacity of any of the technologies considered, making it the most future-proof alternative. The tradeoff for this is the additional construction cost incurred to extend fiber all the way to the premises, making FTTP the most capital-intensive solution considered. On the operational side, the extension of fiber enables the removal of all active components in the outside plant, providing FTTP with a substantial operational savings over competing technologies with active electronics in the outside plant.[106] However, in unserved areas in particular, these savings are insufficient to overcome the initial capital expenditure burden, making FTTP the solution with the highest lifetime cost and the highest investment gap.

Capabilities

There are three basic types of FTTP deployments: point-to-point (P2P) networks, active Ethernet networks and passive optical networks (PON). PON makes up more than 94% of the current residential FTTP deployments in the United States.[107] PON has the advantage of offering lower initial capital expenditure requirements and lower operating expenditures relative to P2P and Active Ethernet deployments, respectively. As such, our analysis utilized PON as the modeled FTTP network.

Exhibit 4-AS shows the capabilities of the varieties of PON currently in use in the United States.[108]

While the majority of homes currently passed by FTTP deployments in the United States are passed by BPON networks, more new deployments are utilizing GPON.[109] PON is a shared medium, meaning that a portion of the access network running between the headend and the passive optical splitter is shared among multiple end-users.

Typical PON deployments share a single fiber in the feeder portion of the access network among 32 end-users. See Exhibit 4-AT. For BPON, this yields a fully distributed downstream capacity of 19.4 Mbps and upstream capacity of 4.8 Mbps per end-user. For GPON, these capacities increase to 78 Mbps downstream and 39 Mbps upstream. As these speeds do not factor in any oversubscription, with a reasonable oversubscription of 15:1,[110] an operator with either a BPON or GPON deployment could easily offer its customers a product with download speeds exceeding 100 Mbps, far exceeding what we anticipate being required in the foreseeable future.[111] As such, FTTP clearly is a candidate from a capability standpoint for delivering broadband to the unserved.

Future PON architectures

PON architectures continue to evolve. The full standard for the next evolution of GPON is expected to be completed in June

2010, with deployments starting in 2012. It will offer download speeds of 10 Gbps and upload speeds of 2.5 Gbps and 10 Gbps, and it will be able to coexist on the same fiber as GPON. Deployments of the next evolution of EPON could even predate those of GPON, offering download speeds of 10 Gbps and upload speeds of 1 Gbps and 10 Gbps.[112] See Exhibit 4-AU.

Beyond these near-term standards, numerous long-term ideas are being presented. For example, Wave Division Multiplexing PON would replace the splitter with an arrayed wave guide and utilize a different wavelength for each end-user. This would effectively eliminate the sharing of the fiber in the second mile that takes place with existing PON varieties, enabling dedicated end-user capacities of 10 Gbps or more.

Exhibit 4-AS: Capabilities of Passive Optical Networks (PON)

	BPON	EPON	GPON
Standard	ITU-T G.983	IEEE 802.3ah	ITU-T G.984
Bandwidth	Downstream up to 622 Mbps	Downstream up to 1.25 Gbps	Downstream up to 2.5 Gbps
	Upstream up to 155 Mbps	Upstream up to 1.25 Gbps	Upstream up to 1.25 Gbps
Downstream wavelength(s)	1490 and 1550 nm	1550 nm	1490 and 1550 nm
Upstream wavelength	1310 nm	1310 nm	1310 nm
Transmission	ATM	Ethernet	Ethernet, ATM, TDM

Exhibit 4-AT: Passive Optical Network (PON) FTTP Deployment

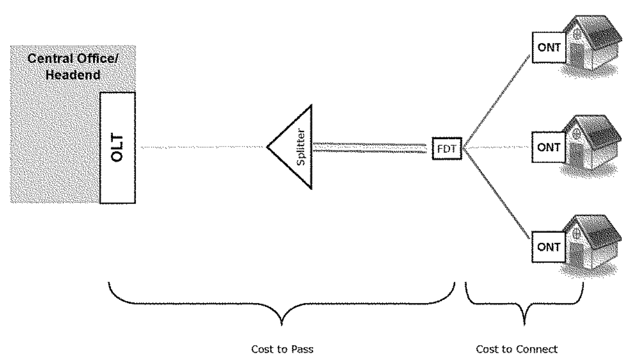


Exhibit 4-AU: Future PON Architectures

	10G GPON	10G EPON
Bandwidth (upstream/downstream)	10/2.5 Gbps or 10/10 Gbps shared	10/1 Gbps or 10/10 Gbps shared
Positives	Compatible with existing GPON	First completed
Key challenges	10 Gbps upstream not viable for single-family units	10 Gbps upstream not viable for single-family homes; 1 Gbps upstream too little bandwidth

FTTP economics

To build FTTP to deliver broadband to the 7 million housing units that are classified as unserved (at a broadband definition of 4 Mbps download and 1 Mbps upload) would lead to an investment gap of $62.1 billion.

The initial capital expenditure averages out to be slightly more than $5,000 per premises. This initial capex value comprises two pieces: the cost to pass a premises and the cost to connect a premises. (These costs are detailed in Exhibit 4-AV.)

The cost to connect a premises is the smaller of the two charges, typically averaging about $650-$750/premises.[113] The cost to connect is entirely success-driven and consists of the installation of the fiber drop and equipment at the customer premises. Making up the bulk of the $5,000 initial capex cost of a FTTP deployment is the cost to pass a premises; this is the cost to build the fiber network distributed over the premises capable of being serviced by the network. Cost-to-pass is typically spoken of in terms of all premises passed by a FTTP deployment, but the more meaningful number is cost-to-pass per subscriber, which takes into account penetration rate. With fiber installation costs ranging between $10,000 and $150,000 per mile, depending on a variety of factors including deployment methodology, terrain and labor factors,[114] the cost to pass is highly sensitive to penetration rate and household density.

Using several data points provided by existing FTTP providers, we are able to establish the following empirical relationship between the cost-to-pass for a FTTP deployment and household density, using standard curve-fitting techniques[115] (see Exhibit 4-AW):

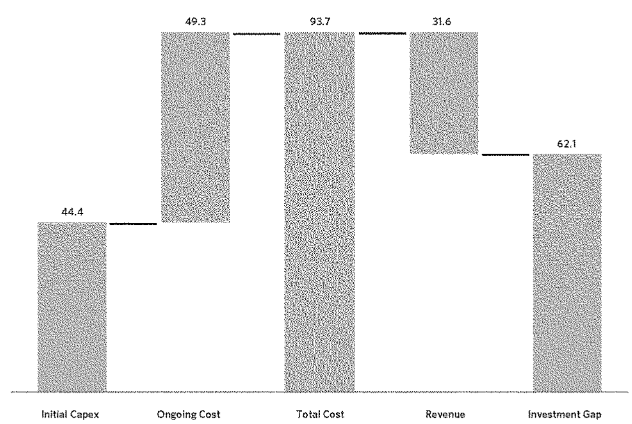
$$\text{Cost per home passed} = \$701.59 * e^{(8.19/\text{Household density})}$$

where Household density is in homes per square mile.

As one can see, the unserved segment starts to intersect the cost-to-pass curve just as the curve starts to steepen significantly. At about 10 households per square mile, the cost-per-premises passed is slightly less than $1,600. Halving the density to five housing units per square mile more than doubles the cost-to-pass, to more than $3,600. At this level, factoring in average broadband penetration of roughly 65% and including the cost to connect each premises yields a cost-per-subscriber in excess of $6,000. Due to the low densities of the unserved segment and given the current expectation of bandwidth demand over the coming years, even with an optimistic scenario for increasing broadband adoption, FTTP may be prohibitively expensive when alternative technologies can also meet bandwidth demands.

The final category of costs is one where FTTP holds a significant advantage: the cost-to-serve. By extending fiber all the way from the serving office or headend to the customer premises, an FTTP network eliminates the need for any active components in the outside plant. This can reduce ongoing maintenance and support expenditures by as much as 80% relative to an HFC plant.[116] However, on a monthly basis for a typical scale network deployment, this savings amounts to just a few dollars per subscriber, and as such is generally insufficient to offset the initial capital expenditure burden.

Exhibit 4-AV:
Breakout of FTTP Gap



FTTP Deployment

The cost information above can be displayed in a simple financial model that can be used to easily estimate the viability of a FTTP deployment in addition to the model that calculates the cost of the investment gap across the country. See Exhibit 4-AX.

First, consider cost per home passed. In this example, we use $850, a value that would cover roughly 80% of the United States. Factoring in a 40% penetration rate, a value taken from the high end of Verizon's publicly stated 2010 target rate for its competitive deployments,[117] we get a $2,125 cost-to-pass per subscriber. Adding in the cost-to-connect, inflated to account for churn and equipment replacement over the life of the network, we get a rough estimate of $3,225 total investment per subscriber. At this level, an operator could succeed with a monthly EBITDA of

Exhibit 4-AW: Cost to Pass with FTTP by Density of Homes[118]

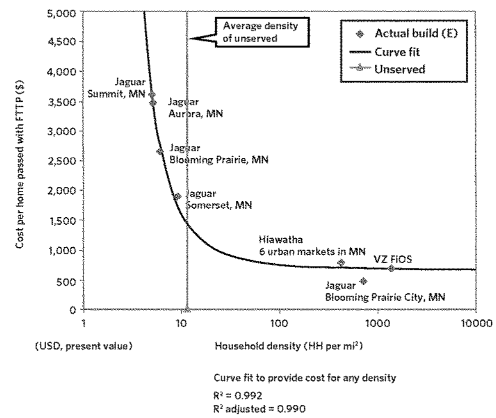


Exhibit 4-AX: Simple Financial Model to Calculate Breakeven EBITDA for FTTP

Cost per home passed	$850
Take rate	40%
Plant cost per sub	$2,125
Cost to connect/maintain	$1100
Total capex per sub	$3,225
Profit for NPV = 0 (over 20 years)	$3,225
Taxes (@ 20% effective rate)	$806
PV of EBITDA required	$4,031
EBITDA per month (@ 10% WACC over 20 years)	$42.50

$650 initial cost to connect
$450 CPE/churn replacement

Low profit target

Ignores potentially significant interest payments and impact on required EBITDA

Assumes customer lifetime is 5 years

Key questions:
- How will EBITDA required for breakeven change as density-driven costs change?
- Is that EBITDA target reasonable?

$42.50/subscriber, a value that is roughly in line with estimates of margins for some of the largest providers in the country.

Next, we calculate the cost to deploy FTTP in each county in the country using the curve fit calculated in Exhibit 4-AW. Applying that cost to the financial model laid out in Exhibit 4-AX, one can calculate the EBITDA required for FTTP to break even in each county; the results are shown in Exhibit 4-AY. Note that a successful FTTP entrant would need to have roughly $38 in monthly EBITDA from each customer at the assumed 40% take rate to provide returns to capital in the denser half of the country.

It is important to note that for an incumbent, much of the revenue associated with a FTTP deployment cannibalizes its existing revenue. As such, an incumbent telco would only want to factor in the incremental revenue offered by a FTTP deployment, namely additional data revenue and video revenue. This has the effect of significantly reducing the viability of FTTP deployments currently for many incumbent providers.

Due largely to this cost structure, there have been few large incumbent providers overbuilding their existing footprints with FTTP. To date, the bulk of FTTP deployments have been driven by a single RBOC, Verizon, which has deployed FTTP in the denser, suburban and urban areas in its footprint, and by Tier 3 ILECs, CLECs, municipalities and other small providers. These providers have deployed FTTP in areas that are less densely populated than those of Verizon, but they have been able to largely replicate the RBOCs' cost structure by achieving an average penetration rate that is nearly double that of the RBOC (54% vs. 30 %).[119]

3,000 - 5,000 foot DSL

Despite providing faster broadband speeds than 12 kft DSL and being capable of delivering video services, DSL over loops of 3,000 (3 kft) feet or 5,000 (5 kft) feet has a higher investment gap when providing broadband services in low-density unserved areas. DSL over 3-5 kft loops delivers broadband speeds well in

Exhibit 4-AY: Esitmated Monthly EBITDA Required to Break Even on an FTTP Build Across the Country[120]

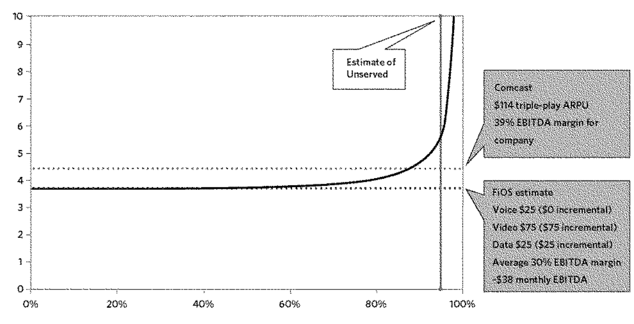


Exhibit 4-AZ: Data Sources for FTTP Modeling

Item	Source
Optical light terminal (OLT)	Calix protective order filing
Fiber distribution hub (FDH)	FTTH Council
optical splitter	FTTH Council
Fiber drop terminal (FDT)	FTTH Council
Optical network terminal (ONT)	FTTH Council, Calix protective order filing
fiber optic cabling	FTTH Council
aerial placement	FTTH Council
buried placement	FTTH Council
operating/maintenance expenses	Hiawatha Broadband protective order

excess of the 4 Mbps downstream and 1 Mbps upstream target. However, due to the cost of driving fiber an additional 7,000 to 9,000 feet closer to the end user, 3 kft DSL and 5 kft DSL are more costly solutions than 12 kft DSL and, thus, have higher investment gaps than 12 kft DSL in all unserved markets.

Capabilities

DSL over loops of 3 kft or 5 kft typically uses VDSL2 technology, which was first standardized in 2006 and uses frequencies up to 30 MHz. While there may be some VDSL technology still being used today, many operators are replacing it with VDSL2. Therefore, we will examine the capabilities of VDSL2 technology at 3 kft and 5 kft.

VDSL2 can provide 35 Mbps downstream and 6 Mbps upstream over 3 kft loops, and it can provide 20 Mbps downstream and 2 Mbps upstream over 5 kft loops. As VDSL2 over 24 AWG wire provides rates well above 4 Mbps downstream and 1 Mbps upstream, the technology meets the speed requirements for broadband service. Exhibits 4-BA and 4-BB illustrate how loop length affects speed for VDSL2. Of course, speeds realized in the field are heavily dependent on plant quality, so

Exhibit 4-BA:
Downstream Speed of a Single VDSL2 Line at Various Loop Lengths [121]

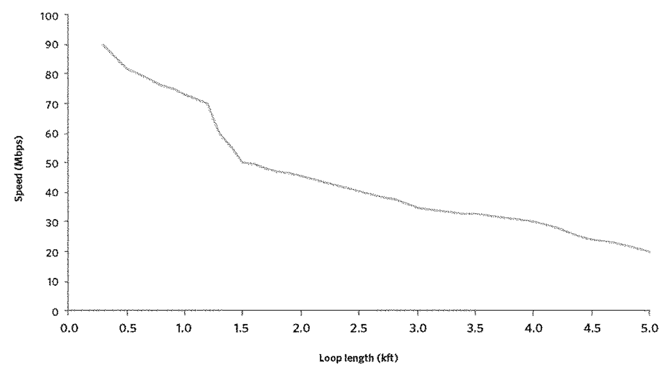
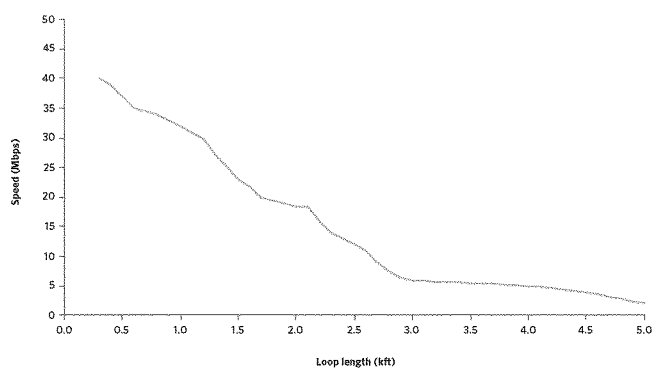


Exhibit 4-BB:
Upstream Speed of a Single VDSL2 Line at Various Loop Lengths [122]



any degradation in the copper plant will lead to lower speeds for a given loop length.

In this case, 24 AWG wire is assumed with no bridged taps. Performance with 22 AWG wire, which is often used in rural areas, would yield higher bitrates, while use of 26 AWG wire would yield lower rates.

For VDSL2, performance can be improved through vectoring, bonding or a combination of the two. Vectoring, or Dynamic Spectrum Management level 3 (DSM-3), has shown improved performance in lab tests by canceling most of the crosstalk between VDSL2 lines sharing the same binder and is currently being tested in the field. The bonding of loops, assuming there are two copper pairs available, would enable the doubling of the speed achieved to the end-user. A combination of vectoring and bonding could produce downstream speeds over 300 Mbps if lab and field tests prove successful. Exhibits 4-BC and 4-BD illustrate the performance of bonded and vectored VDSL2.

Operators who have shortened loops from 12 kft to 3-5 kft and currently use VDSL2 technology have seen DSL technology offer faster speeds in the past decade.[123] Current and future

Exhibit 4-BC: Downstream Speed of VDSL2 Variants[124]

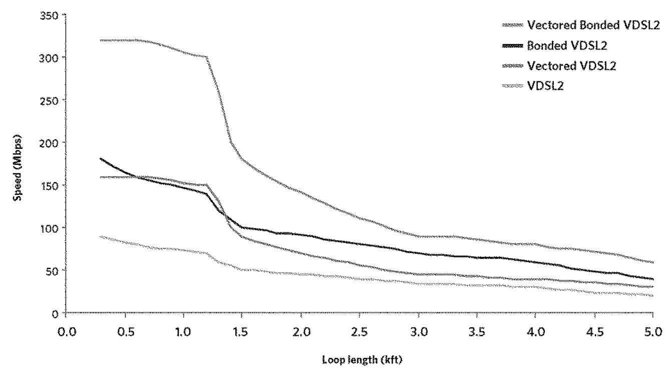
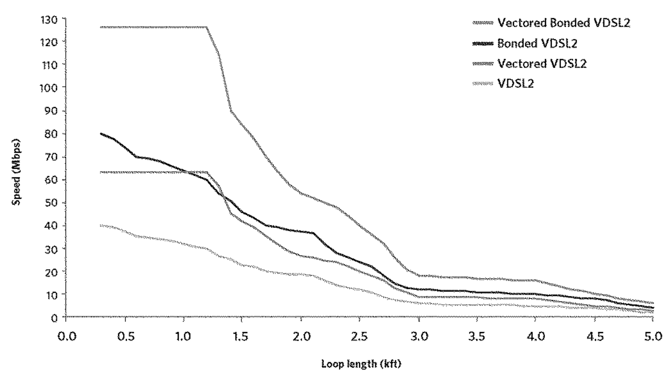


Exhibit 5-BD: Upstream Speed of VDSL2 Variants[125]



technology improvements, such as the three levels of DSM, are likely to continue to improve speeds as well as the stability of the service provided. Further development of and investment in these improvements, along with bonding, are likely due to DSL's prevalence worldwide.

We model the VDSL2 access network in a similar fashion to the ADSL2+ network described (see above for details). In essence, we assume VDSL2 DSLAMs are connected to central office and other middle- and second-mile aggregation points with fiber-optic-based Ethernet technology providing backhaul capacities that are more than sufficient to meet the end-user requirement. Costs associated with loop conditioning are included when appropriate.

Economics

Like those of the 12 kft DSL network, the economics of the 3 kft DSL and 5 kft DSL networks depend on revenues, operating costs and capital expenditure. Using granular cost data from DSL operators, the model calculates the investment gap to deploy 3 kft DSL to unserved markets as $52.7 billion and the investment gap to deploy 5 kft DSL to unserved markets as $39.2 billion. The total gaps for 3 kft and 5 kft DSL are more than twice as costly as the respective number to deploy 12 kft DSL to the unserved, despite 3-5 kft DSL earning nearly 3x the revenue of 12 kft DSL because their ARPUs include video as well as data. The cost differential is mainly driven by the high cost of driving fiber closer to the end user, less so by the higher cost of VDSL2 technology versus ADSL2+ technology. The following waterfall charts show the breakout among initial capital expenditure, ongoing costs and revenue. See Exhibits 4-BE and 4-BF.

Initial Capex

Initial capital expenditures include material costs and installation for the following: telco modem, NID, protection, aerial or buried copper drop, DSLAM, cabinet, VDSL2 line card, allocated aggregation cost, fiber cable up to 3 kft or 5 kft from the end-user (respectively), feeder distribution interface and drop terminal/building terminal, as well as the engineering costs for planning the network and the conditioning required on loops (i.e., the removal of load coils and bridged taps).

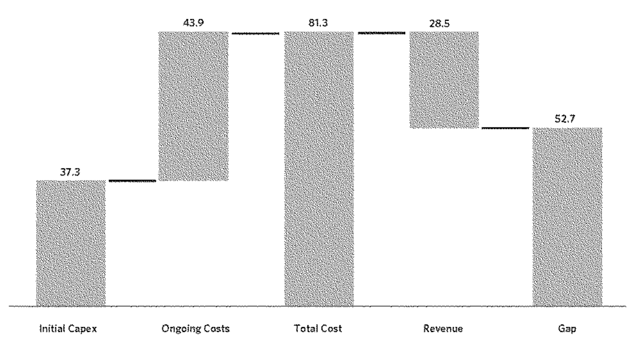
Ongoing Costs

Ongoing costs include replacement capital expenditure required to replace network components at the end of their useful lives, network administration, network operations center support, service provisioning, field support, marketing and SG&A.

Revenues

Revenues are calculated by taking the ARPU—which varies according to the level of broadband service/speed provided as well as whether the bundle of services provided includes voice, data and video—and multiplying it by the average number of users. For 3 kft and 5 kft DSL, data and video ARPUs are used as the incremental services to voice, which is assumed present due to the fact that DSL technology utilizes the twisted pair of copper wires originally installed and used for POTS. VDSL2's higher speeds at 3 kft and 5 kft could support both video and data, although not all real-world operators of VDSL2 choose to offer both services today. The addition of video revenue is not enough to compensate for the incremental investment required to drive fiber within 3 kft and 5 kft of the end user for the unserved.

Exhibit 4-BE:
Breakout of 3,000-Foot DSL Gap



Material and labor costs for 3 kft and 5 kft DSL are the same as for 12 kft DSL except for VDSL2 line cards, which are sourced from a Qwest filing under Protective Order.

15,000 foot DSL

DSL over loops of 15,000 feet (15 kft) is a very cost-effective solution for providing Internet access in low-density areas but fails to meet the Broadband Availability Target.

Capabilities

DSL over 15 kft loops typically uses ADSL2/ADSL2+ technology. ADSL2+ over 24 AWG wire provides rates of 2.5 Mbps downstream and 600 kbps upstream; therefore, the technology does not meet the speed requirements for broadband service under the Broadband Availability Target. Refer to Exhibit 4-AH in the 12 kft DSL section for a further understanding of how downstream speed varies with loop-length distance.

Hybrid Fiber-Coax Networks

The focus in this section will be on high-speed data connectivity provided by hybrid-fiber-coax (HFC), or cable, networks. We'll look first at the capabilities of HFC networks, then at the economics of these services.

Our analysis indicates that the capabilities of HFC networks far exceed end-user speed and network capacity requirements, as shown above and in the National Broadband Plan. Therefore, by

Exhibit 4-BF:
Breakout of 5,000-Foot DSL Gap

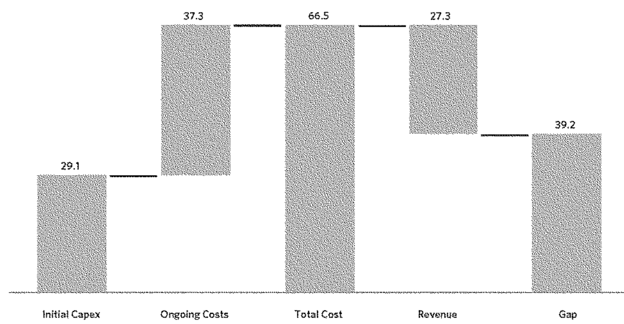
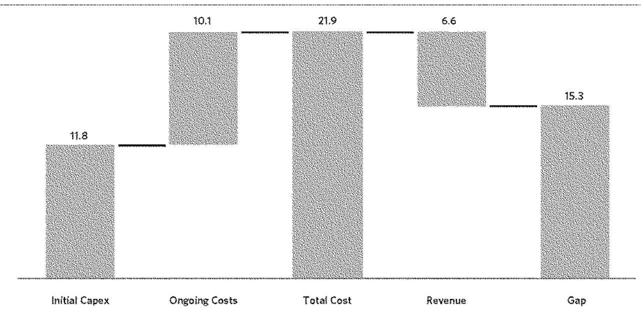


Exhibit 4-BG:
Breakout of 15,000-Foot DSL Gap



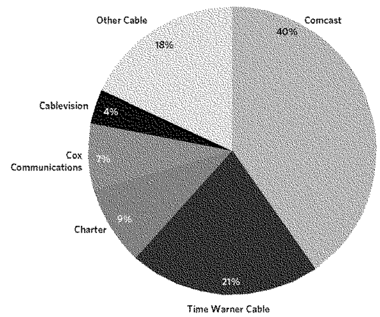
definition, homes within the HFC footprint are considered served. However, the investment gap to deploy HFC networks in unserved areas is larger than that of DSL or fixed wireless as noted above.

The near-ubiquity of HFC networks that can provide high-speed broadband access is a tremendous asset that puts the United States in a unique position among other countries. HFC networks were initially designed to deliver one-way video, but have evolved over time to allow two-way transmission of data and voice in addition to video. Today, cable systems pass roughly 90% of U.S. households with high-speed data services; in addition, more than 90% of homes are passed by cable plant, with 50% of those homes taking at least basic cable video service, thereby amounting to 63 million subscribers.[126] Some 52% of broadband subscribers in the United States subscribe to cable-based service, the second highest rate among OECD countries.[127]

History

When cable systems were initially constructed, the industry was highly fragmented, with many small firms operating networks in local markets. Today, there is very little overlap in cable networks because, in most markets, cable operators received exclusive rights to operate in their geography in the form of a franchise agreement granted by local franchising authorities. It is important to note that cable companies have not been subjected to the same network-sharing or carrier-of-last-resort obligations as the telephone companies; however, cable companies do not receive Universal Service Fund (USF) monies to offset the costs of constructing and maintaining their networks. Maintaining one network per geographic area greatly reduced the network cost-per- subscriber, which, along with having monopoly or near-monopoly control over the video market, has allowed these networks to be successful in the face of large up-front capex requirements.

Exhibit 4-BH:
Breakout of Cable Coverage— Share of Homes Passed by Cable Companies



Numbers do not sum to 100% due to rounding.

Due to the complementary nature of footprints and scale advantages in content acquisition, the cable industry has experienced significant consolidation over the years. Today, there are almost 1,200 cable system operators but, as shown in Exhibit 4-BH, the top five companies pass 82% of homes passed by cable video service.[128]

Cable MSOs have spent $161 billon from 1996-2009 on capital expenditures; in part, this was used to enable broadband capabilities.[129] Cable systems were originally constructed to provide one-way video signals, so customers initially could not send information back through the network. In the early deployment of cable (1950s-1970s), the networks were known as CATV (Community Antenna Television) and were built to provide TV and radio services. The network was designed to support all-analog, one-way transmissions from the community satellite antennas (cable headends) to end-user televisions over coaxial cable.

In the 1990s with the advent of the Internet and passage of the 1996 Telecommunications Act, cable companies began upgrading their networks to provide the two-way transmission capabilities required for Internet data traffic and telephony in addition to TV/radio signals. The network needed to be reengineered to handle two-way transmissions of digital communication signals and upgraded to handle higher capacity demands. The original "tree and branch" architecture of cable systems was ideal for transmitting TV signals from the headend to the home television. However, video transmission over coaxial cable was still susceptible to noise and interference and required amplifiers, line extenders and other active electronics to ensure that the signal would reach end-user TV sets with acceptable quality. Unfortunately, these active electronics a) were not capable of passing signals in the upstream direction and b) were often not spaced properly within the cable plant for upstream transmission. As a result cable companies invested in HFC upgrades throughout the 1990s to overcome these problems. Such upgrades were seen as attractive since millions of homes were already "wired" with high capacity coaxial cable and the revenue potential of triple play services created a compelling business case. Exhibit 4-BI illustrates some examples of the infrastructure upgrades required for HFC networks.

Steps to upgrade cable networks for broadband:

- Invest in fiber optic cable and optic/electronics to replace and upgrade coaxial cable for capacity purposes

➤ Replace and redesign headend equipment, line transmission equipment, set top boxes to allow for two-way data transmission, and add DOCSIS modems
➤ Deploy telephone switching equipment and interconnection facilities to provide VoIP services
➤ Develop the technology and equipment necessary for more sophisticated network management and control systems
➤ Implement the back-office, billing and customer service platforms necessary to provide the standard triple play services common among cable operators today

Capabilities

Cable companies coupled their investments in two-way upgrades with a standardization effort. Cable-based broadband relies on Data Over Cable Service Interface Specification (DOSCIS). The first release of DOCSIS was in 1997, with DOCSIS 2.0 released in 2001 and the third-generation standard (DOCSIS 3.0) now being deployed widely. DOCSIS 2.0, currently the most widely deployed, provides up to 36 Mbps of downstream bandwidth and up to 20 Mbps upstream, while DOCSIS 3.0 provides up to 152 Mbps of downstream bandwidth and up to 108 Mbps of upstream (with four bonded channels).[130]

As noted above, cable systems provide shared bandwidth in the last mile, with multiple homes sharing a fixed amount of bandwidth at a single node. Ultimately, bandwidth-per-customer is driven both by the number of customers (and their usage) per node and the total bandwidth available per node. Given typical busy-hour usage rates (see Network Dimensioning section), users on a DOCSIS 2.0 system can receive up to 10 Mbps;[131] under DOCSIS 3.0, that number will increase substantially, to 50 Mbps.[132] Actual figures, however, depend on a large number of variables, including not only the DOCSIS specification, but also spectrum allocation and use and the number of homes per node.

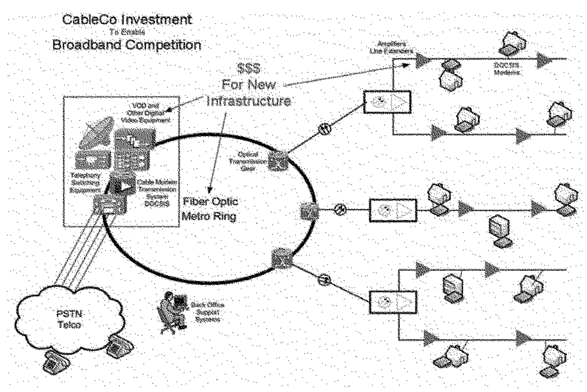
Impact of cable-system spectrum

Spectrum in cable plants, as in over-the-air broadcasting, is a measure of how much "real estate" is devoted to transmitting signals. Most two-way cable plants use 450 MHz or more of spectrum, with many having been upgraded to provide 750 MHz or more. Each analog television channel requires 6 MHz of spectrum. Exhibit 4-BJ shows the spectrum allocation for a typical 750 MHz, DOCSIS 2.0 deployment.

Note that all upstream communications take place in low-frequency spectrum, below 52 MHz. FCC rules requiring that broadcast Channel 2 be carried on Channel 2 of the analog spectrum (54 – 60 MHz) established the low end of downstream spectrum.[133] Cable companies' outside plant equipment is tuned for this: band-pass filters allow upstream traffic only below 52 MHz. In addition, band-pass filters in consumer electronics are tuned to block potentially large amplitude upstream signals only below 52 MHz.

The 52-MHz upper bound on upstream spectrum places limits on upstream bandwidth. First, because it would require

Exhibit 4-BI: Upgrades to Enable Broadband Services



changes to cable plant and consumer electronics, adding spectrum for upstream use above the 52 MHz would be difficult and costly. In addition, interference at low frequencies (e.g., from motor noise, ham and CB radio, walkie-talkies) could reduce usable upstream spectrum significantly.[134] While DOCSIS 3.0 allows for the bonding of multiple channels to increase upstream capacity, these other spectrum issues will likely provide real-world limits to upstream capacity.

Downstream bandwidth faces fewer constraints; cable companies can devote higher-frequency 6 MHz channels to downstream capacity. In addition, DOCSIS 3.0 allows carriers to devote four or even eight channels to downstream data communications.

Cable companies use Quadrature Amplitude Modulation ("QAM") to increase the bandwidth transmitted over a given amount of spectrum (the Mbps-per-MHz), with typical deployments featuring 16, 64 or 256 QAM. In typical DOCSIS 2.0 deployments, the downstream direction is 64 or 256 QAM and the upstream is 16 QAM. As an example, consider a typical DOCSIS 2.0 deployment with one 6 MHz downstream channel at 64 QAM which delivers approximately 36 Mbps.

Cable companies can create additional capacity for downstream bandwidth (or for additional broadcast video channels, or other services like video-on-demand) through a number of means. The most obvious may be to increase the frequency of the cable plant, but this requires extensive upgrades in outside plant and is often very expensive.

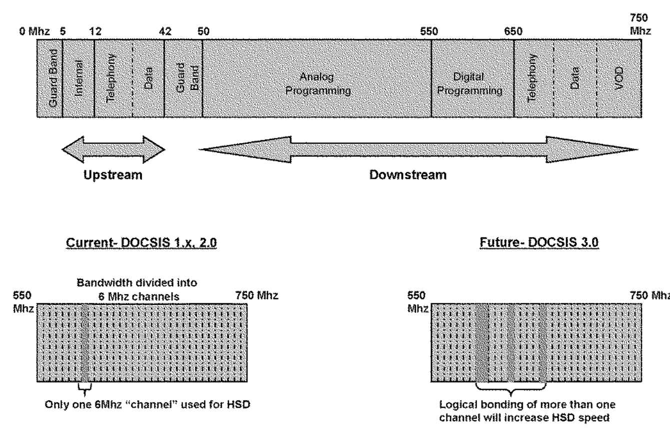
There are a number of less expensive options available.

As discussed above, going from DOCSIS 2.0 to DOCSIS 3.0 allows the cable system to devote more frequency, assuming it can be made available, to data while keeping the plant total unchanged. Cablevision estimated the cost of its DOCSIS 3.0 rollout at about $70 per home passed (there may be additional success-based expense, e.g., CPE). Scale economies may bring that number 10-20% lower for larger MSOs.[135]

Another option is Switched Digital Video (SDV). In the current HFC architecture, all video channels are sent to all subscribers with filtering of channels for different subscription services made by the set-top box. SDV transmits only those channels to a given node when those channels are in use by a subscriber. This means that the majority of channels are not transmitted most of the time, thereby using fewer channels in aggregate. SDV is therefore a relatively inexpensive technique to reclaim on the HFC network bandwidth to be used for other purposes. Cisco Systems estimates the cost of SDV at $12-$16 per home passed.[136] A number of MSOs are moving forward with SDV,[137] although concerns exist for third party providers of DVRs like TiVo.[138]

Another approach is analog reclamation. In analog reclamation, often termed "going all digital," cable companies move away from transmitting analog signals entirely. A single analog channel takes up 6 MHz (the equivalent of more than 30 Mbps as noted above); the same spectrum (or bandwidth) can carry 10 digital standard-definition channels or three high-definition channels. Analog reclamation can therefore "add" a substantial number of channels to a typical system. For example, by

Exhibit 4-BJ: Spectrum Allocation in Cable Plant



moving a fairly typical 85 analog channels to digital, a cable company can free up over 500 MHz of spectrum, providing enough capacity to carry well over 200 digital HD channels. The cost of analog reclamation is estimated at approximately $30 per home passed.[139]

Finally, cable companies could go all-IP, moving away from the current spectrum allocation entirely. A 750-MHz system could provide 4.5 Gbps[140] of all-IP bandwidth, to be shared among all users and all applications. This would require a significant change not only in network architecture for cable companies, but also significant business-process redesign to figure out how to capture revenue from an all-IP network.

Impact of homes per shared node

As noted above, cable capacity is shared among all users on a given node. Where there are more users, bandwidth is shared more widely and individual users will, on average, have less capacity. By splitting nodes, cable companies can reduce the user-load per node and increase the capacity per user. Some cable companies have been splitting nodes aggressively, moving from 1,000 homes per node to 100 homes per node or fewer.[141] Cisco estimates the cost of splitting a node at approximately $1,500.[142] Assuming 300-400 homes per node puts the cost at approximately $50 per home passed.

As node-splitting continues, HFC networks will reach the point where the run of coaxial cable is quite short—short enough that there is no need for active electronics in the coaxial part of the network. These so-called passive nodes often have roughly 60 homes per node,[143] but the driver is the linear distance covered by the coaxial cable, not the number of homes. Removing active electronics from the field, however, will yield a network that is more robust and that requires less maintenance.

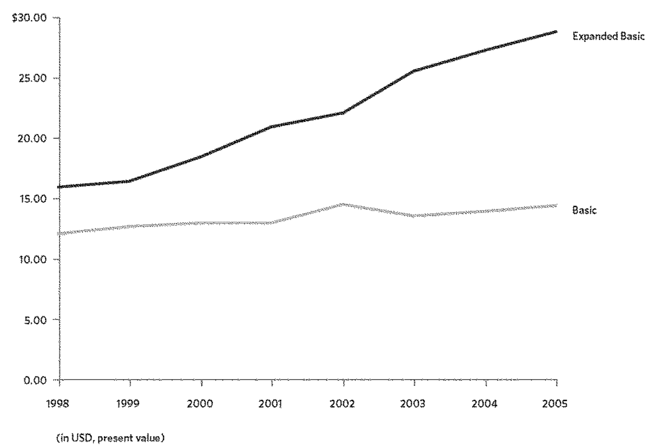
Economics

The economics of providing broadband service over cable plant are driven largely by the presence of existing network. Where networks exist, and costs are sunk, broadband economics are very attractive. In other areas, where one examines greenfield builds, the economics can be far more challenging. Since the network capabilities of an HFC network far exceed the target speed set forth in the plan, the unserved are all in greenfield areas where the investment gap of HFC is much larger than that of DSL or fixed wireless.

Existing cable deployments were funded by video

As noted earlier, cable networks were originally designed to offer video service. And, in many markets, cable companies were granted exclusive franchise agreements. As a result, the video business over

Exhibit 4-BK: Cable Video ARPU Over Time[144]—Cable Pricing



time has accounted for a large portion of cable-company revenue, providing a network on which to build the incremental broadband business. The video business, in fact, has enjoyed increasing ARPU over a long period of time (see Exhibit 4-BK), providing much of the capital for HFC investment in infrastructure. Of all subscribers who have access to these services, 88% subscribe to expanded basic and 55% subscribe to digital programming.[145]

Incremental broadband upgrades

As noted above, large investments have been made in cable systems already, principally funded by the video business. Further, as shown in Exhibit 4-BL, the incremental expense for upgrades—each aspect of which has been discussed previously—is low given the significant sunk investment already in the cable plant. As a consequence, cable systems are relatively well positioned to meet

Exhibit 4-BL: Upgrade Costs for Cable Plant

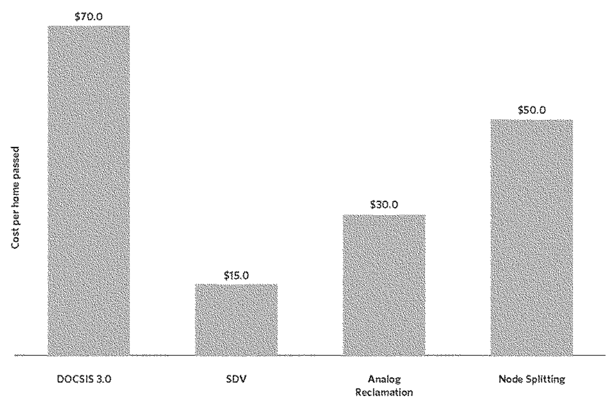
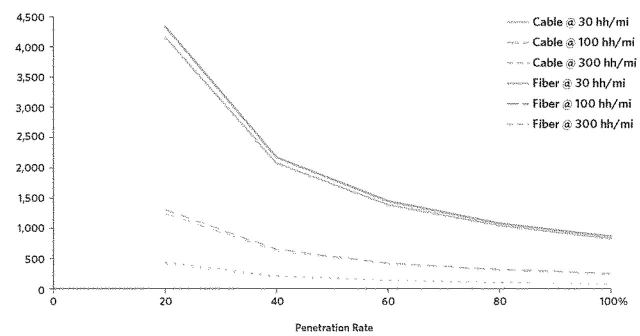


Exhibit 4-BM: Outside Plant Cost, FTTP or RFoG vs. HFC—Relative Capex Costs of Cable and Fiber, Excluding Headend Equipment[146 147]



Dollars of capex/sub/mile; penetration rate future growth in bandwidth demand.

In summary, where existing two-way cable plant exists, upgrade costs to provide high-speed service of up to 50 Mbps are low: roughly $165 per home passed.

Greenfield deployments

Building a new cable plant requires deploying a new outside plant and some form of headend to aggregate and distribute video and data content. The choice of technology for the outside plant is not an obvious one: providers can deploy a network that is a traditional hybrid fiber-coax plant, or one that is all fiber, a so-called RF over Glass (RFoG) plant.

When connecting a home for the first time—effectively adding a completely new last-mile connection—providers are likely to use the most future-proof technology possible. It would make little sense to deploy, for example, a brand-new long-loop twisted-pair network. The choice is less clear when comparing HFC and RFoG (or any other FTTP deployment). As Exhibit 4-BM shows, HFC and fiber networks have similar outside plant costs, which are mostly a function of labor costs. However, RFoG and FTTP deployments, by removing all active electronics from the outside plant, have lower ongoing expenses.

Estimates suggest these opex savings are approximately $20 per home passed per year.[148] While this may not sound large at

Exhibit 4-BN:
HFC Plant Diagram—CableCo HFC Architecture

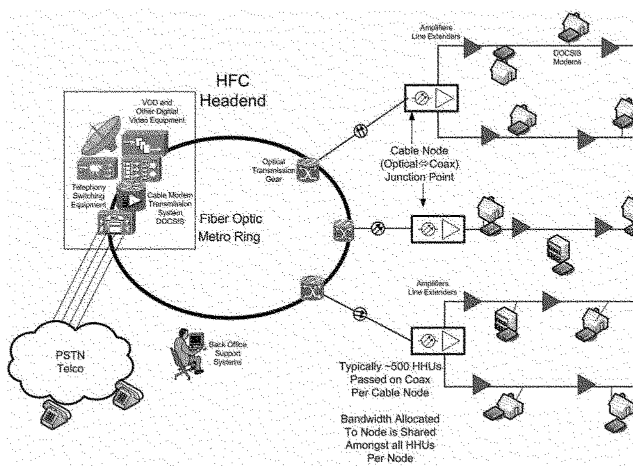


Exhibit 4-BO:
Data Sources for HFC Modeling

Material Costs	Source
Splitter	Cable ONE (filed under protective order)
Fiber Node	Cable ONE (filed under protective order)
CMTS	Hiawatha (filed under protective order)
Up Stream Reciever	Hiawatha (filed under protective order)
Cable Modem	Hiawatha (filed under protective order)
Drop	Hiawatha (filed under protective order)
Tap	Cable ONE (filed under protective order)
Coaxial Cable	Cable ONE (filed under protective order)

the outset, it adds up over the life of the network. A majority of these savings come from power required for active components, system balancing and sweeping, and reverse maintenance.

The other major expense for a new network, whether HFC or RFoG, is the cost of a drop per subscriber. RFoG drops are approximately $175 more expensive than HFC drops.[149] As a consequence, the initial cost of connecting a subscriber is higher for RFoG relative to HFC.

However, the aggregate cost of a typical HFC customer will exceed, in less than 10 years, the aggregate cost of serving the same customer using RFoG. In other words, the operational savings from having an all-passive plant outstrip the initial cost savings from deploying an HFC system. It is reasonable to expect RFoG and FTTP drop costs will decline over time as deployments become increasingly mainstream and the industry attains greater scale. Accordingly, it is likely that as RFoG and FTTP deployments become cheaper, this break-even period will become even shorter. As a consequence, a greenfield developer of wireline infrastructure is more likely to choose RFoG or FTTP over HFC going forward, given both lifecycle cost and future-proofing benefits of an all-fiber network.

Modeled cost assumptions

We modeled the incremental costs of extending HFC networks into unserved areas with a high degree of granularity. Exhibit 4-BN shows the basic network elements of an HFC network and Exhibit 4-BO lists the sources for assumptions used in the model.

NETWORK DIMENSIONING

In order to ensure that the investment gap is reflective of the full costs of deployment, it is important to dimension the network to be able to deliver target broadband speeds during times of peak network demand. In particular, we need to determine that we properly model the capacity of every shared link or aggregation point in order to ensure that the network is capable of delivering required broadband speeds.

However, data flows are far more complex to characterize than voice traffic, making relatively straightforward analytical solutions of aggregated data traffic demand very challenging; this will be discussed ahead in **Complexities of data-network dimensioning**. Our approach is to describe typical usage patterns during times of peak demand, which we then use to estimate the network capacity needed to ensure a high probability of meeting end-user demand; this is discussed at the end of this chapter in **Capacity considerations in a backhaul network**.

Complexities of data-network dimensioning

Network dimensioning will not guarantee that users will always experience the advertised data rates. Note that even traditional voice networks are designed for a certain probability of being able to originate a phone call (e.g. 99% of the time in the busy hour for wireline, 95% for cellular) and a certain average sound quality. For dimensioning IP data networks, it may be useful to point out the difficulty of applying traditional voice traffic engineering principles to IP data-traffic flow. Dimensioning IP data networks is intrinsically more complex than dimensioning voice networks.

To properly dimension a traditional circuit switched voice network, it is typical to use the Erlang B formula that allows an operator to provision the number of circuits or lines needed to carry a given quantity of voice traffic. This is a fairly straightforward process mainly because the bandwidth consumed for each call is effectively static for a given voice codec in the busy hour. In fact, technology has enabled carriers to encode speech more efficiently so a voice conversation today may actually consume much less bandwidth than a voice conversation did 20 years ago. Nonetheless, the three basic variables involved are:

- Busy Hour Traffic, which specifies the number of hours of call traffic there are during the busiest hour[150]
- Blocking, or the failure of calls due to an insufficient number of lines being available and
- The number of lines or call-bearing TDM circuits needed in a trunk group

As long as the average call hold time is known and the operator specifies the percentage of call blocks it is willing to accept in the busy hour, the number of trunks is easily calculated using the Erlang B formula.

For broadband Internet access, however, there is much more uncertainty. Unlike voice telephony, Internet traffic is quite complex, multi-dimensional, and dynamic in the minute-to-minute and even millisecond-to-millisecond changes in its characteristics. Network planning and engineering for broadband Internet are more difficult with higher degrees of uncertainty because of the following principal factors:

- Each application used during an Internet access session, such as video streaming, interactive applications, voice, Web browsing, etc., has very different traffic characteristics and bandwidth requirements.
- End-user devices and applications are evolving continuously at the rate of silicon electronics, as opposed to voice (we continue to speak at the same rate of speech).
- Broadband Internet access supports many different user applications and devices, from streaming high definition video (unidirectional, very high bandwidth), to short messaging (bidirectional, very low bandwidth).
- The scientific community has not yet developed and agreed upon the best mathematical representations for modeling Internet traffic.

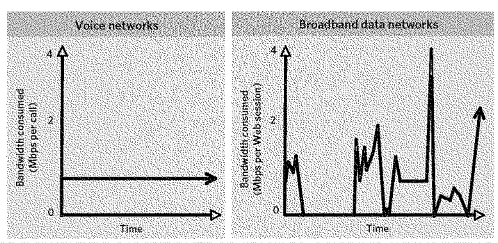
Exhibit 4-BP illustrates the additional complexities of multi-dimensional data traffic verses traditional circuit switched voice traffic. These differences introduce chaotic variables not present in the Erlang traffic model used to dimension voice networks.

Many individual Internet applications are "bursty" in nature. Consider a typical Web-surfing session, in which a user will "click" on an object, which results in a burst of information painting the computer screen followed by a lengthy period of minimal data transmission, followed by another burst of information. The instantaneous burst may occur at several Mbps to paint the screen, followed by many seconds or even many minutes with essentially no traffic, so the average transmission rate during a session may only be a small percentage of the peak rate. This type of traffic does not lend itself to modeling by the traditional mathematical models such as the Erlang formulas used for voice traffic; it can be considered fractal and chaotic in nature, as shown in Exhibit 4-BP. By contrast, the viewing of a high-definition video involves streaming content in one direction steadily at several Mbps. And a typical Skype video conference may involve a two-way continuous streaming of information but at only at around 384 kbps in each direction.[151]

Computer processing keeps improving at the rate set forth by "Moore's Law," as does the price/performance of storage. This doubling every two years enables much better performance of existing applications (e.g., very refined graphics instead of simple pictures, high definition and now even 3D-HD instead of NTSC video or standard-definition TV), as well as new applications that could not have existed several years earlier. So as long as silicon chips and electronics continue to improve, network providers may see more and more demands placed on the network by individual user applications. Moreover, behind an individual network interface, the subscriber is likely to have a local area network with several users running various applications for which traffic characteristics vary widely and with variable timescales such that the cumulative effect is a highly variable and unpredictable traffic flow into the network.

To conclude this discussion, we note that traffic engineering is based on mathematical models involving probabilities and statistics. As noted earlier, modeling voice traffic makes use of the simple inputs of average duration of call, bits-per-second used by the voice encoding scheme and number of call originations per hour. This has enabled scientists and engineers over the years to develop reliable mathematical models that correlate well with real-world experience. However, for Internet traffic, the number of variables, the magnitude of variation of these variables and the statistical nature of the variables have made it difficult for the scientific community to develop

Exhibit 4-BP: Differences Between Voice and Data Networks



Factor	Relevance to voice network dimensioning	Relevance to data network dimensioning
Number calls/data sessions	Number of calls generated in the busy hour	Number of sessions invoked by user or users during busy hour
Average call/session duration	Average duration of each call (usually in minutes)	Duration of application session (range from hours to milliseconds)
Variation in call/session duration	**Almost all calls measured in minutes with little deviation**	Variable session duration between applications ranging from minutes to seconds to milliseconds
Bandwidth intensity (amplitude)	**N/A- bandwidth consumed for each call is static at 64 kbps**	Bandwidth consumed per application session (Variable based upon active application)
Variation in bandwidth intensity	**N/A (see previous)**	Wide variation of bandwidth consumption for different applications
Calls Blocked / Congestion threshold during busy hour	"blocked" calls tolerated in the busy hour (typically one call block per 100 call attempts)	Minimum bandwidth at which packets are lost

a well-accepted mathematical model that can predict network traffic based on end-user demand. In fact, the underlying behavior of the traffic is still the subject of research and debate.

Consequently, it is very difficult to statistically characterize the traffic per subscriber or the aggregated traffic at each node in the network. And without such a characterization, we cannot dimension the network, *ex ante*, with the level of precision necessary to ensure subscribers will always experience the advertised data rates.

Generally speaking, Internet traffic engineers do not drive the expansion of network capacity from end-user demand models. Rather, they measure traffic on network nodes and set thresholds to increase capacity and preempt exhaust for each critical network element. Adtran remarks in its filing: "While sustainable speed can be measured in existing networks, it is nearly impossible to predict in the planning stages due to its sensitivity to traffic demand parameters."[152]

Still, we need to engineer our network model to deliver a robust broadband experience, capable of delivering burst rates of 4 Mbps in the download and 1 Mbps in the upload even without being able to measure traffic on actual network elements. The approach to do this is to provide sufficient capacity to provide a high probability of a robust user experience (as discussed in the next section). For this, we need a metric that characterizes traffic demand. One such metric that measures traffic demand is the Busy Hour Offered Load (BHOL) per subscriber.[153]

Capacity per user: busy hour offered load (BHOL)

The data received/transmitted by a subscriber during an hour represent the network capacity demanded by the subscriber during that hour. This can be expressed as a data rate when the volume of data received/transmitted is divided by the time duration. BHOL per subscriber is the network capacity demand or offered load, averaged across all subscribers on the network, during the peak utilization hours of the network.

In general, the total BHOL at each aggregation point or node of the network must be smaller than the capacity of that node in order to prevent network congestion. Alternately, the number of subscribers per aggregation node of the network must be smaller than the ratio of the capacity of the node to the average BHOL. This is the general principle we use to dimension the maximum number of subscribers at each aggregation point of the network model.

The BHOL-per-subscriber depends on a subscriber's Internet usage pattern and, as such, is a complicated overlay of the mix of Internet applications in use, the bandwidth intensity of each application and the duration of usage. But, for practical engineering purposes, the average BHOL-per-subscriber can be derived from monthly subscriber usage. Typically, 12.5% to 15% of daily usage happens during the busy hour.[154] We recognize that very high monthly usage on the same connection speeds usually results from increased hours spent online, outside of the busy hours, rather than an increased intensity of usage during the busy hours. As such, very heavy usage may not quite lead to the same proportionate increase in BHOL. However, for the purposes of our network dimensioning, we shall make the simplifying (and conservative) assumption that the effect is proportionate.

Current usage levels and corresponding BHOLs for different speed tiers are shown in Exhibit 4-BQ. Observe that the mean usage is more than five times that of the usage by the median or typical user. In fact, a small percentage of users generate an overwhelming fraction of the network traffic as shown in Exhibit 4-BR. This phenomenon is well known and is discussed in more detail in Omnibus Broadband Initiative, Broadband Performance.[155] For example, the heaviest 10% of the users generate 65% of the network traffic. So, if we were to exclude the capacity demand of these heaviest users, the BHOL of the remaining users would be far lower. For example, by excluding the heaviest 10% of the users, the BHOL by the remaining 90% is only 36-43 kbps. In Exhibit 4-BS, we show the impact on the BHOL by excluding different fractions of the heaviest users. For comparison, we also show the BHOL for the median or typical user.

Suppose we want to dimension a network that will continue to deliver 4 Mbps to all users even after the next several years of BHOL growth. In order to estimate the future BHOL, we first note that average monthly usage is doubling roughly every three years as discussed in Omnibus Broadband Initiative, Broadband Performance.[156] Next, given the significant difference between mean usage and the typical or median user's usage, it is likely that the service provider will seek to limit the BHOL on the network using reasonable network management techniques to mitigate the impact of the heaviest users on the network. For example, an Internet service provider might limit the bandwidth available to an individual consumer who is using a substantially disproportionate share of bandwidth and causing network congestion. Exhibit 4-BS shows the BHOL for possible scenarios, ranging from dimensioning for the typical user to mean usage. For our network dimensioning purposes, we shall use a BHOL of 160 kbps to represent usage in the future. Thus, this network will not only support the traffic of the typical user, but it will also support the traffic of the overwhelming majority of all user types, including the effect of demand growth over time. It is also worth noting that the additional cost of adding capacity on shared links, as described throughout this paper, is low.

Capacity considerations in a backhaul network

Operators of IP broadband networks must provide a consistent, reliable broadband experience to consumers in the most cost-effective way that meets the consumer broadband requirements set forth in the Broadband Plan: 4 Mbps downstream and 1 Mbps upstream of actual speed.

An important consideration for an economical deployment of affordable broadband networks is proper sizing and dimensioning of the middle- and second-mile links. A fundamental element in the design of all modern packet-switched networks is "sharing" or "multiplexing" of traffic in some portions of the network to spread costs over as many users as possible.[157] In other words, network operators can take advantage of the network capacity unutilized by inactive applications and/or users by dynamically interleaving packets from active users and applications thus leading to a better shared utilization of the network. This is commonly known as statistical multiplexing.

This ability to dynamically multiplex data packets from multiple sources contributes to packet-switched networks being more

Exhibit 4-BQ: Monthly Usage and BHOLs by Speed Tier

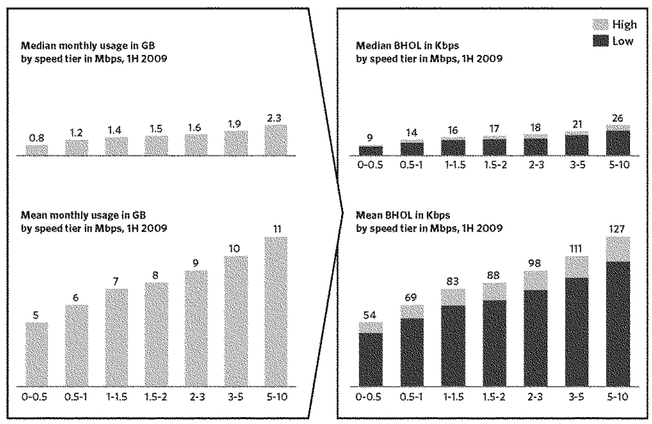
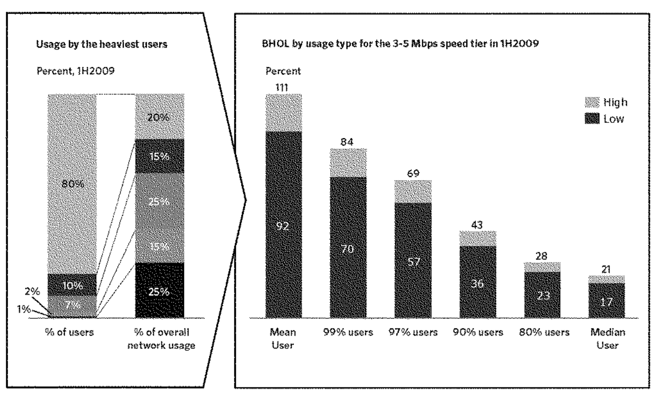


Exhibit 4-BR: Usage by Tier and BHOL



efficient and economical than circuit-switched networks. Shared network resources are the principle of network "convergence" in practice. Voice, video and data applications like Web browsing and other applications noted above are now all packetized and transmitted using the same network transmission facilities.

Of course there is a downside to shared networks, which are typically oversubscribed in order to exploit the benefits of statistical multiplexing. Oversubscription refers to the fact that the maximum aggregate demand for capacity at a shared link or node in the network can exceed the link or node capacity. Thus, there is a risk, however small, that the total traffic presented at a given time might exceed transport resources in a way that will, in turn, result in congestion, delay and packet loss.

Even though it is challenging, *a priori*, to accurately characterize the user experience on a network because of the complexity of characterizing the traffic per subscriber, we used some available analytical tools to validate the network dimensioning assumptions in our model. Specifically, in Exhibit 4-BT,

Exhibit 4-BS:
Expected Future BHOL in Broadband Network Dimensioned to Deliver 4 Mbps—Expected BHOL in kbps for Different Usage Types in 2015

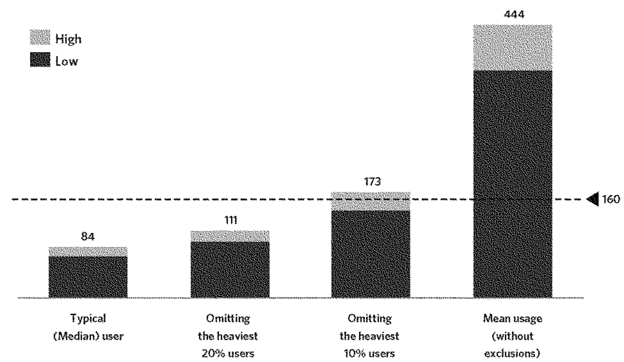
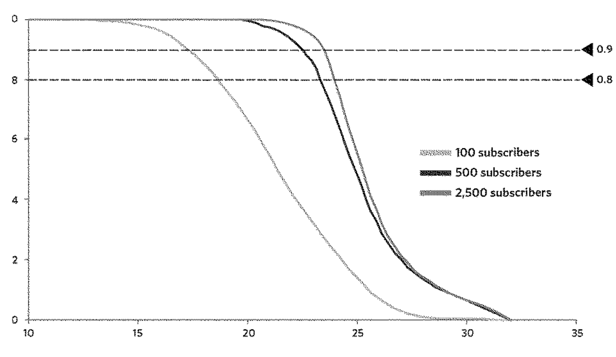


Exhibit 4-BT
Likelihood of Achieving a Burst Rate Greater Than 4 Mbps at Different Oversubscription Ratios with a Varying Number of Subscribers[158]



we show the likelihood of being able to burst at rates greater than 4 Mbps on a shared *wired* or *satellite* link at different oversubscription ratios. For convenience, we shall refer to this likelihood as simply "burst likelihood."

In Exhibit 4-BT, the case with 100 subscribers is meant to represent a typical HFC node with ~100 subscribers; the 500 and 2,500 subscriber curves, on the other hand, represent a DSLAM with ~500[159] and a satellite beam with ~2,500 subscribers, respectively.

We use this chart to validate the network dimensioning assumptions in our model. For example, the chart shows that for a burst likelihood of 90%, the maximum oversubscription ratio on a link with 100 subscribers is approximately 17. Recall that oversubscription ratio of a link of capacity C Mbps with N subscribers who have an actual data rate of R Mbps is:

$$\textit{Oversubscription ratio} = \frac{(\textit{Number of subscribers}) \times (\textit{Actual Speed})}{(\textit{Link Capacity})} = \frac{N \times R}{C}$$

That implies that the link capacity must be greater than approximately 23.5 Mbps. Since the capacity of a DOCSIS 2.0 HFC node is about 36 Mbps, we conclude that a single DOCSIS 2.0 node, which serves about 100 subscribers can deliver our target broadband speeds with high likelihood. We can use the same approach to validate the dimensioning of shared links and aggregation points in other networks like DSL, Satellite and FTTP.[160]

We recognize that the results shown in the chart are based on certain traffic demand assumptions,[161] and that these assumptions may not hold in practice. Still, given our conservative choice of parameters in our network models, these results indicate that the network will support the required broadband speeds with very high probability. In reality, network operators may monitor traffic levels at different links within their networks and engineer their respective oversubscription ratios to ensure that capacity in the shared portions of the network is available to support offered service levels; in this case, 4 Mbps download and 1 Mbps upload in the busiest hours of the network.

One very interesting implication of the traffic simulation represented in Exhibit 4-BT is that higher oversubscription rates for the larger number of subscribers mean that capacity can grow more slowly than the number of subscribers. This is due to improved statistical multiplexing with increased number of users. For example, adding five times more subscribers, moving from 100 to 500 or from 500 to 2,500 subscribers, requires adding only roughly four times as much capacity to provide the same probability of end-user service. Thus, adding capacity linearly with the number of subscribers, as we assume in our analysis, is a conservative approach that does not account for the full benefits of statistical multiplexing.

MIDDLE-MILE ANALYSIS

Middle-mile facilities are shared assets for all types of last-mile access. As such, the cost analysis is very similar regardless of last-mile infrastructure. The local aggregation point can vary based on technology (e.g., a cable headend, LEC central office or a wireless mobile switching center (MSC)) while the Internet gateway is a common asset. Middle-mile facilities are widely deployed but can be expensive in rural areas because of the difficulties of achieving local scale, thereby increasing the investment gap. On a per-unit basis, middle-mile costs are high in rural areas due to long distances and low aggregate demand when compared to middle-mile cost economics in urban areas.

While there may be a significant affordability problem with regard to middle-mile access, it is not clear that there is a middle-mile fiber *deployment* gap. The majority of telecom central offices (approximately 95%)[162 163] and nearly all cable nodes (by definition, in a true HFC network) are fed by fiber.

Please note: terms like "backhaul," "transport," "special access" and "middle-mile" are sometimes used interchangeably, but each is distinct. To avoid confusion, "middle-mile transport" refers generally to the transport and transmission of data communications from the central office, cable headend or wireless switching station to an Internet point of presence or Internet gateway as shown in Exhibit 4-BU.

Middle-Mile Costs

The middle-mile cost analysis concludes that the initial capex contribution to serve the unserved is 4.9% of the total initial capex for the base case. That is, the modeled cost for the incumbent or lowest cost provider to build these facilities incrementally is estimated at approximately $747 million.

In order to accurately model the costs of middle-mile transport, particularly in rural, unserved areas, we examined all available data about the presence of reasonably priced and efficiently provided, middle-mile transport services. However, we recognize that broadband operators who rely on leased facilities for middle-mile transport may pay more for middle-mile than broadband providers who self-provision. This is discussed further within the subsection titled **Sensitivity: Lease vs. Build**. Thus, in a hypothetical case in which leasing facilities turns out to be four times the modeled incumbent build cost, the resulting middle-mile contribution could be estimated as high as 9.8% of the total initial capex for the base case, or approximately $1.6 billion. The following discusses the analysis done to ensure our model accurately captures the appropriate costs.

Broadband networks require high-capacity backhaul, a need that will only grow as end-user speed and effective load grow. Given the total amount of data to be transmitted, optical fiber backhaul is the required middle-mile technology in most instances. Once the transport requirement reaches 155 Mbps and above, the only effective transport mode is at optical wavelengths on a fiber optic-based transmission backbone. Plus, while the initial capital requirements of fiber optic systems are substantial, the resulting infrastructure provides long-term economies relative to other options and is easily scalable.[164] Microwave and other terrestrial wireless technologies are well suited in only some situations such as relatively short middle-mile runs of 5-25 miles. However, microwave backhaul may be a critical transport component in the second mile, primarily for wireless backhaul as discussed in detail in the wireless section.

Approach to Modeling Middle-Mile

The costs associated with providing middle-mile services are heavily dependent on the physical distances between network locations. Therefore, the approach to modeling middle-mile costs revolves around calculating realistic distance-dependent costs.

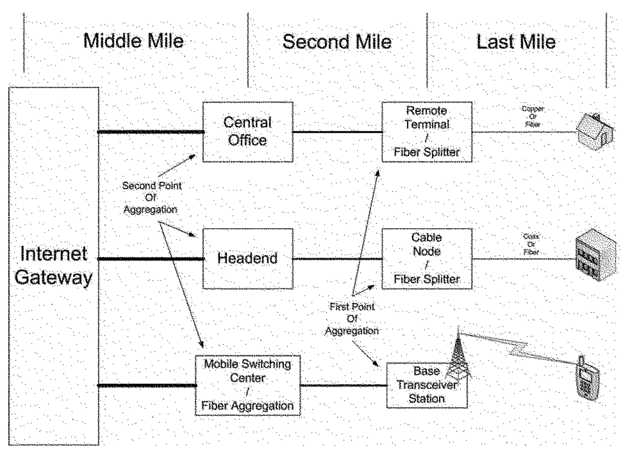
Our focus is on ILEC central offices given the availability of information on their locations. Starting with the location of ILEC central offices and the network homing topology, we estimated the distances and costs associated with providing middle-mile service. Since the cost estimate is distance-dependent, calculating the cost requires making an assumption about the routing used to connect LEC offices as will be discussed below. This same approach—mapping known fiber locations and their logical hierarchy to calculate the distances and costs for providing middle-mile service—could apply equally well to cable headends, or CAP, or IXC POPs given thorough information on their locations. However, publically available information on exact locations of cable headends, private IXC fiber POPs and other entity fiber node locations is limited; thus, the focus exclusively on ILEC fiber suggests that this analysis will significantly underestimate the presence of fiber around the country.

The following sections describe the process of collecting and processing data, along with the cost inputs and assumptions used in the model. The gap calculation assumes internal transfer pricing: i.e., the incremental cost the owner of a fiber facility would assign to the use of the fiber in order to fully cover both the cash cost and opportunity cost of capital. Importantly, as discussed below, this cost may be substantially lower than the price a competitor or other new entrant, like a wireless provider, may be charged for the same facility.

Middle-Mile Data Collection

- Identify all ILEC Central Offices (CO) and obtain each Vertical and Horizontal coordinates (analogous to latitude and longitude)

Exhibit 4-BU:
Breakout of Middle, Second & Last Mile



- Identify all Regional Tandems (RT) within their respective LATA locations and determine which Central Office subtends which RT

After the middle-mile anchor node locations and hierarchical relationships between the nodes are captured, the distances between these nodes must be calculated so that the distance-dependent cost elements can be applied appropriately.

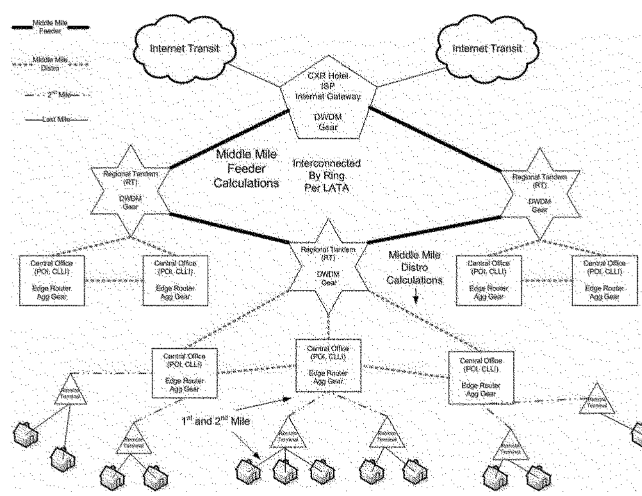
Middle-Mile Processing Steps

- Each subtending CO is assigned to its nearest RT to create the initial relation of COs to RTs.
- COs are then routed to other COs that subtend the same RT using shortest distance routing back to their respective RTs (i.e., we calculate a shortest-distance route to connect the COs to their respective RTs). To achieve this route, the process starts at the CO coordinate farthest from the appropriate RT and selects the shortest CO-to-tandem distance based on airline mileage. The CO starting point is prohibited from routing back to itself and must route toward the tandem. This approach minimizes the amount of fiber needed.
- The RTs within a given LATA are routed together in a ring.
  - The shortest ring is chosen by comparing the distances between RTs and selecting the shortest ring distance within each LATA; this distance is then used for the middle-mile feeder calculations.
  - It is assumed that the Internet gateway peering point is located on the RT ring. In this manner, all COs that are connected to the RT ring have access to the Internet.
  - Internet gateway sites are assumed to be located in regional carrier collocation facilities (known commonly as "carrier hotels"). We estimate there are some 200 of these located regionally throughout the United States.
- The middle-mile calculation is run state-by-state and stored in one central distribution and feeder table.

Tree vs. Ring architecture

- The design depicted in Exhibit 4-BV represents a hub-and-spoke hierarchy interconnected via closed rings. The model contemplates that a typical ILEC would likely interconnect end office, tandems and regional tandems in redundant-path "ring architecture."

Exhibit 4-BV: Topology Used for Middle-Mile Cost Modeling



- By assumption, the fiber link and distance calculations between COs and RTs are increased by a factor of 1.8 to account for the redundant, geographically diverse, fiber spans that would be required in ring architecture as opposed to a hub-and-spoke architecture. Note that this assumption could be fairly conservative (i.e., assuming higher than necessary costs) given degree of interconnection among the COs.

Cost Allocations on Facility

These middle-mile facilities by nature and design are engineered as shared infrastructure facilities that aggregate end-user traffic and transport traffic to regional Internet gateways. The cost of a particular middle-mile facility cannot be allocated solely to the consumer broadband users of that facility. Since that facility is shared with other provider services such as residential and enterprise voice, wholesale carrier services, enterprise data services and other management services utilized by the provider, the cost needs to be allocated appropriately.

- The model assumes that the total cost of the facility is allocated thus: 1/3 for service provider voice service, 1/3 wholesale and enterprise carrier services and 1/3 consumer broadband services. This is an estimation of the allocation of traffic within a typical ILEC transport environment, but the allocation of cost to any single product or customer group is speculative at this point.
- The model only calculates the consumer broadband services portion of the facility and assumes that BHOL doubles roughly every three years.

Nationwide Middle-Mile Fiber Estimation

Data sources about fiber routes or even the presence of fiber in a given LEC office are extremely limited. Consequently, we created our best approximation of fiber facilities available for middle-mile service; detail on that process is provided below. The overwhelming majority of telecom central offices (approximately 95%)[165 166] and nearly all cable nodes (by HFC definition) are fed by fiber.

The map shown in Exhibit 4-BW is an illustration of the paths of fiber used in our calculation to connect ILEC offices (and only ILEC offices). While it is based on as much real and calculated data as are available, we had to make a number of assumptions about the specific routes. Therefore, while we believe this map represents an accurate, if conservative, estimate of middle-mile fiber, it is not appropriate for network-planning purposes.

The diagram in Exhibit 4-BW is an estimation based on:

- Known locations of ILEC CO
- Topology based on a Gabriel Network[167] topology was considered but likely overestimated the number of links of fiber distribution. Thus, a Relative Network Neighborhood[168] distribution was chosen given the set of points representing the CO locations.
- Approximately 90% ILEC Fiber CO deployment, which is significantly lower (i.e., more conservative) than most estimates. Exhibit 4-BX, which shows the distribution of fiber-fed CO based on known services available per CO.

Exhibit 4-BW contemplates ILEC fiber only. Estimating the presence of middle-mile fiber based only on the fiber that connects LEC central offices, while excluding the fiber networks of cable companies, CAPs, CLECs and other facilities-based providers, systematically underestimates the presence of fiber. If one imagines overlaying the fiber optic facilities that have been deployed by other entities—such as Tier One IXCs/ISPs (ATT, Sprint, GX, Verizon Business, Level 3, XO, TWTC, etc.); Nationwide and regional Cable Operators (Comcast, Cox, Time Warner, Charter etc); Competitive Fiber Providers (Abovenet, Zayo, Deltacom, 360 Networks, Fiberlight, Alpheus etc.); private fiber deployments (hospitals and institutional); municipal fiber; and utility fiber—it becomes clear that the United States is generally well connected coast-to-coast.

In the limited instances where LEC fiber is not available, Windstream[169] has found that the exchanges typically have the following reasons for lack of deployment:

- The exchange is an island exchange (i.e., isolated from other exchanges in the LECs footprint) or part of a small, isolated grouping of exchanges;
- Fewer than 1,000 access lines fall within the exchange; and
- The closest point of traffic aggregation is more than 50 miles away from the CO.

The combination of a small customer base and long transport distances can make it impossible to build an economic case for fiber deployment.

However, recognizing that fiber-based middle-mile services are physically deployed does not necessarily mean that they are always economically viable in every rural area. The challenge is that access to such fiber may not be available at prices that result in affordable broadband for businesses, residents and anchor institutions, as discussed in the following section.

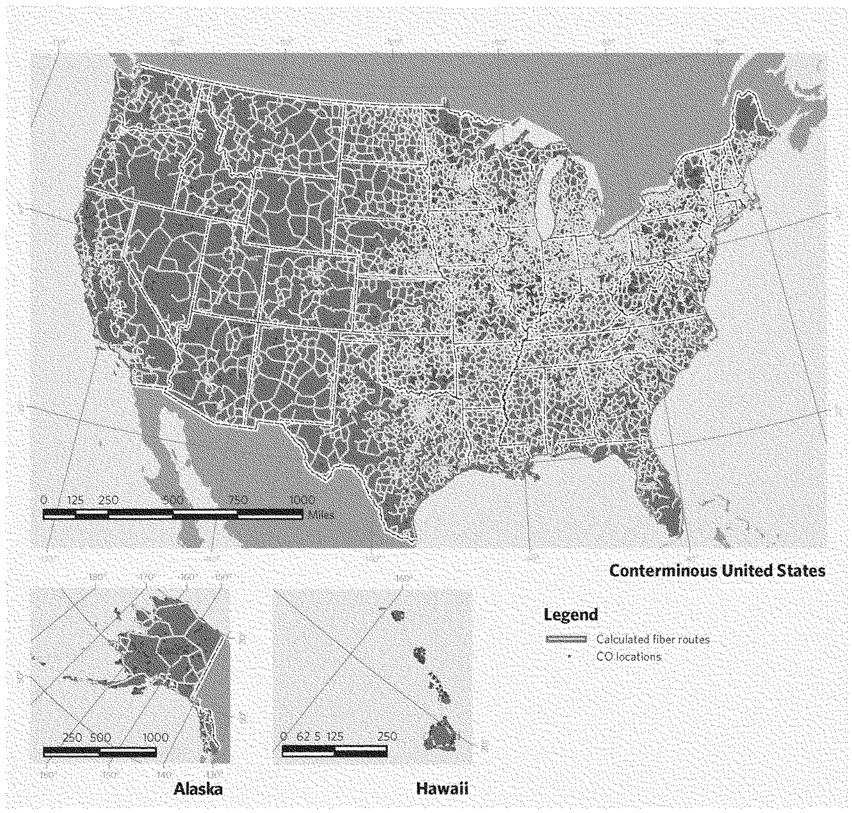
Costs Drivers for Middle-Mile Transport

Transporting data 50 miles or more from a local CO or other access point to the nearest Internet point of presence is a costly endeavor.

The costs of these facilities are proportional to their lengths. In urban or suburban areas, the cost of new fiber network construction varies widely, roughly from $4 to $35 per foot where the largest cost component is installation. The cost range depends on whether the fiber is suspended from utility poles or buried, the number of fiber strands in the cable, right-of-way costs, terrain, soil density and many other factors.[170] In the model, we assume that in rural settings, even for inter-CO transport facilities, 75% would be aerial construction. Of the 25% buried construction, the model calculates fiber burial costs that take into account local terrain, including soil composition.

Providing fiber-based service to low-density areas carries with it higher per-user costs. These costs are driven by larger distances which, even when offset by lower per-foot costs, lead

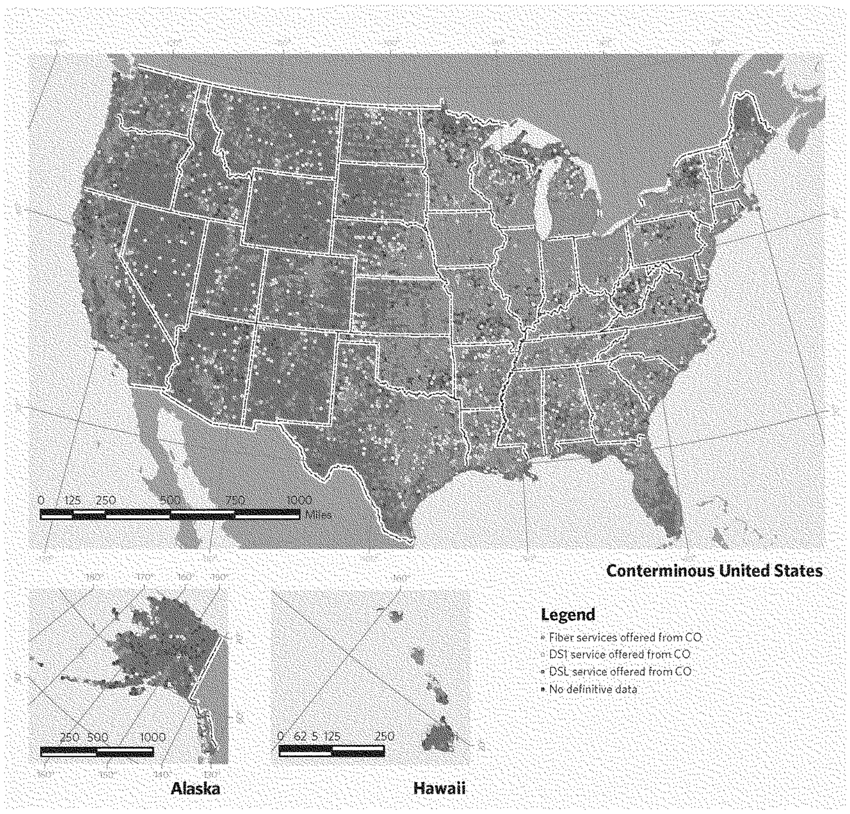
Exhibit 4-BW:
Calculated Telco Fiber Routes



to higher total cost per link. In addition, there are simply fewer users per link. Given that middle-mile links have very high fixed costs yet low costs associated with adding capacity, larger connections are more cost-effective per bit than smaller links. This is reflected in the prices shown in Exhibit 4-BY.

The low density and demand in rural areas, coupled with the volume-dependent middle-mile cost structure, mean that rural broadband operators do not benefit from the same economies of scale common among providers in denser areas. The distances at issue in unserved areas are much longer than typical

Exhibit 4-BX:
Classification of Central Offices for Creating Fiber Map



special access connections. Moreover, low population density prevents the aggregation of demand that would allow rural carriers to use lower-cost, high-capacity links.[171]

Pricing data are difficult to obtain. Tariffs are widely available but "street prices," including all contract savings and contract-term penalties, are not as readily available. Different discount structures, terms and agreements can cause great variability in middle-mile rates. As part of its COMMENTS ON NBP NOTICE #11, the NTCA provided Exhibit 4-BY that shows that while prices of middle-mile connections are indeed dependent on volume, they also vary widely across providers and geographies.[172] The highest and lowest prices vary by more than an order of magnitude for services below about 100 Mbps.

Exhibit 4-BY illustrates that on a per-unit basis, higher capacity middle-mile facilities are more economical than low-capacity facilities. According to NTCA and NECA filings, the average middle-mile cost contribution per subscriber per month is approximately $2.00 in study areas using middle-mile Ethernet connections of higher than 1,000 Mbps.[173] This can be compared to areas using middle-mile Ethernet connections of less than 10 Mbps, that resulted in monthly middle-mile costs per user of approximately $5.00 or more.[174] Again, these data are consistent with the premise that larger pipes carry lower costs per bit, suggesting the benefit for communities in smaller and less-dense areas to aggregate demand for homes and businesses as much as possible and that long-term commitments to utilize these facilities be in place.

Sensitivity: Lease vs. Build

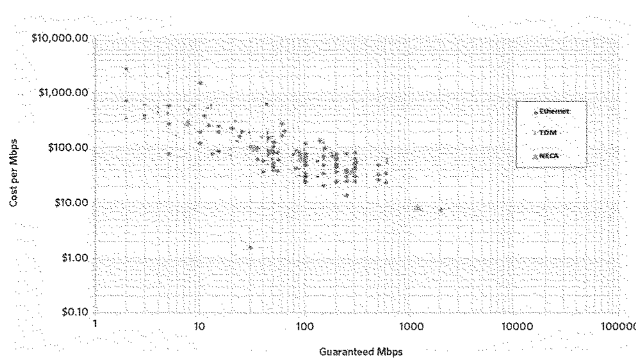
The base case assumes that operators in unserved areas have access to middle-mile transport at economic pricing—cost plus a rate of return. To the extent that middle-mile transport prices exceed this cost-plus pricing model, middle-mile costs can be higher for carriers leasing capacity. The broadband team models the cost to incrementally build middle-mile fiber facilities from scratch to a) understand the overall middle-mile cost contribution for the unserved and b) to establish a baseline middle-mile cost with which to compare to leased middle-mile costs.

The analysis in Exhibit 4-BZ compares middle-mile facility connections of different distances, connection sizes and methods to highlight the lease vs. build decision. Leasing facilities from an incumbent carrier, when properly sized for capacity demand, carries higher costs than the modeled cost for the incumbent provider to build these facilities incrementally. Thus broadband operators who rely on leased facilities for middle-mile may pay more for middle-mile costs than incumbent broadband providers.

To arrive at these estimates, we examine randomly chosen regional routes as shown in Exhibit 4-BZ. Separate "city-pair" routes were selected specifically in rural areas that are homed back to regional carrier collocation facilities (CCF) or "carrier hotels." These particular towns and CCF pairs were selected based upon known locations of CCFs to avoid Tier One MSA access points to best represent rural middle-mile connections. For each route, we calculate the applied tariff rate for the appropriate connection, applying a 30% discount rate for each connection. We recognize, however, that discount levels can range from 10-70% from "rack rates" and that a particular provider in an area may pay more or less than modeled.

NECA Tariff #5 was used as these tariffs are published, and we believe NECA carriers are likely to provide these rural

Exhibit 4-BY: Middle-Mile Cost Dependency on Capacity



Cost per Mbps by Guaranteed Mbps per Connection middle-mile connections. The towns were selected such that they are likely to be in the high-cost study group in accordance with NECA rate band blends.[175] In its comments, NECA suggests that on average, 1 Mbps is required in the shared portions of the network for every 14.5 users for a typical consumer best-effort DSL service.[176] We use this ratio in the analysis and size middle-mile capacity to provide 1 Mbps for every 14.5 users. For example, in the Exhibit 4-BZ for Flasher, ND, the middle-mile capacity required to support 351 HUs is 24 Mbps. In order to provide middle-mile support in Flasher ND, the lowest-cost facility likely available for lease large enough to carry the required 24 Mbps is a DS-3, which has a capacity of 45 Mbps. This need to "overbuy" capacity is repeated as demand requires the lease of larger facility tiers from DS3 to OC3 to OC12, etc. This illustrates the importance of demand aggregation and capacity utilization in the middle mile.

We also estimate the incremental cost that the owner of existing fiber facilities would assign to the use of these facilities in order to fully cover both the cash cost and opportunity cost of capital along these routes. The cost of the build includes the fiber deployment costs (labor, plowing, trenching, pole attachments, ROW, etc.) and the fiber optic electronics (DWDM transport nodes, regenerators, aggregation electronics, etc.). The capacity of the middle-mile network was modeled as 40 Gbps between interoffice nodes. While we believe that the modeled electronics are very high capacity and represent future scalability, it should be understood that included in this cost model is the fiber itself, which is virtually unlimited in capacity as electronics are upgraded. While we make assumptions about the allocation of cost to the modeled services as discussed in the previous section entitled "Approach to Middle-Mile Model," we also estimate the full cost of providing service along these routes as a price ceiling. The results of the analysis are summarized in Exhibit 4-BZ.

Exhibit 4-BZ suggests that on a per-unit basis, it is cheaper to build than to lease. However, that does not necessarily imply that for a given (small) user base and limited capacity demand that the lowest cost option is to build. Cost-per-unit for fiber builds is highly sensitive to scale and utilization. Consequently, it is possible that cost-per-unit for a build is actually higher than lease when demand and utilization are subscale. There is still a question regarding the extent to which leased facility pricing in rural areas is reflective of high deployment costs—long distances driving high-cost deployments that can be amortized over only a small base of end users—or of rent-seeking by facilities owners. The Federal Communications Commission is currently undertaking a proceeding to address special access pricing generally, not only with regard to interoffice transport in rural areas.[177] That proceeding will delve in greater depth into the question of costs and pricing.

In order to connect some rural areas, providers must deploy

Exhibit 4-BZ: Middle-Mile Build vs. Lease Comparison

From City	To City	# of unserved HU	Airline miles between	Circuit size	Build cost per HU per month	Lease cost per HU per month	Lease Premium
Nenana, Alaska	Juneau, Alaska	315	648.96	DS3	$26.99	$302.44	1020%
Bagdad, Ariz.	Phoenix, Ariz.	206	100.32	DS3	$36.49	$93.34	156%
Irwinton, Ga.	Macon, Ga.	934	26.95	OC3	$3.46	$10.10	192%
Libby, Mont.	Missoula, Mont.	2,372	127.95	OC12	$10.89	$12.93	19%
Fort Sumner, N.M.	Ruidoso, N.M.	701	113.87	OC3	$28.22	$31.86	13%
Flasher, N.D.	Bismark, N.D.	351	32.66	DS3	$16.73	$28.06	68%
Lindsay, Okla.	New Castle, Okla.	834	29.46	OC3	$4.87	$11.76	141%
Glide, Ore.	Eugene, Ore.	759	51.76	OC3	$11.19	$17.28	54%
Denver City, Texas	Brownfield, Texas	455	35.24	DS3	$17.98	$22.44	25%
Eureka, Utah	Provo, Utah	578	31.02	DS3	$3.61	$16.65	361%
Rock River, Wyo.	Cheyenne, Wyo.	30	73.32	DS3	$155.63	$516.23	232%
Sheffield, Ala.	Huntsville, Ala.	3,570	58.88	OC12	$1.93	$5.00	159%
Hope, Ark.	Fouke, Ark.	3,465	32.65	OC12	$2.40	$3.75	56%
Buena Vista, Colo.	Colorado Springs, Colo.	2,592	70.96	OC12	$5.29	$7.75	47%
Ketchum, Idaho	Boise, Idaho	1,532	92.00	OC3	$2.92	$12.46	326%
Monticello, Miss.	Hattiesburg, Miss.	2,746	50.59	OC12	$2.09	$5.94	184%
Winchester, Tenn.	Chattanooga, Tenn.	5,145	46.77	OC12	$1.46	$3.03	107%
Pomeroy, Wash.	Walla Walla, Wash.	893	45.15	OC3	$9.99	$13.59	36%
Fayetteville, W. Va.	Beckley, W. Va.	2,780	24.30	OC12	$0.86	$4.11	381%

middle-mile facilities over considerable distances at significant cost. These challenges are further compounded by the fact that these areas often do not have the population density necessary to generate the type of demand that justifies the large investment needed to construct these facilities.[178] The list below summarizes the basic conclusions based upon the middle-mile analysis:

- The distances at issue in unserved areas are much longer than typical special access connections and the low housing-unit or population density results in demand that is insufficient for lower cost high-capacity links.[179]
- As Internet demand increases, the total middle-mile cost for all providers will rise.
- Rural broadband operators do not benefit from the economies of scale on middle-mile facility cost in comparison to urban providers.

CHAPTER 4 ENDNOTES

1 *See* Section 5, Wireless Technology, for a discussion of wireless second mile backhaul.

2 While we realize that a typical fully configured DSLAM would likely support no more than ~350 subscribers, we used 550 to show maximum subscribers that can be achieved at a DSLAM aggregation point (RT or CO) using Fast Ethernet backhaul.

3 Note that the number of simultaneous video streams is driven by capacity of the cell site, not the coverage which is limited by upstream signal strength as discussed below.

4 Simultaneous streams assume non-real-time streams/videos with sufficient buffers at the receiver. Capacity with real-time traffic requirements, such as is required with video-conferencing applications, will be lower. The 480Kbps and 700Kbps video streams here are typical Hulu video streams. *See* Hulu typical video streaming requirements, http://www.hulu.com/support/technical_faq, February 2010. The 1Mbps video stream corresponds to a high-def Skype video conference.

5 UBS Investment Research, "US Wireless 411," August 14, 2009.

6 A paired 2x20MHz of spectrum refers to a spectrum allocation where downlink and uplink transmissions occur on two separate 20MHz bands.

7 Enhanced technologies, such as multiple antenna technologies (aka MIMO), can also help. *See* Wireless Technology section below for more detail.

8 In the bands below 3.7GHz, 547MHz is currently licensed as flexible use spectrum that can be used for mobile broadband. The NBP recommends an additional 300MHz be made available within the next five years.

9 Yankee Group, "North America Mobile Carrier Monitor," December, 2009.

10 Theoretical peak rate inside a cell, does not take into account many real world deployment issues or cell-edge average rate.

11 The CDMA family of standards has its own 4G evolution called UMB. However, UMB is no longer in development and most worldwide CDMA operators have already announced plans to adopt either WiMAX or LTE for when they upgrade to 4G. In the United States, for example, Verizon has chosen LTE while Sprint is planning to deploy WiMAX.

12 Includes total cost of network plus success based capital for subscribers.

13 Based on American Roamer mobile coverage data, August 2009.

14 In 2G systems, by contrast, the signals were transmitted over 200kHz and 1.25MHz.

15 For a more detailed exposition on these multiple access techniques, see, for example, "Fundamentals of Wireless Communication," David Tse and Pramod Viswanath, as well as references therein.

16 Letter from Dean R. Brenner, Vice Pres., Gov't Aff., Qualcomm Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (Dec. 9, 2009) Attach. A at 2. Figure shows downlink capacities calculated for 2x10MHz spectrum availability. Estimates of spectral efficiency calculated for each technology with the following antenna configuration: WCDMA, 1x1 and 1x2; HSPDA, Rel.5, 1x1; HSPA Rel. 6, 1x2; HSPA, Rel. 7, 1x1 and 1x2; LTE, 1x1 and 1x2.

17 *See*, for example, "Fundamentals of Wireless Communications," David Tse and Pramod Viswanath, for details on Shannon theory as well as multi-user scheduling.

18 Our estimate of the limit is based on a simplified evaluation of the "single-user" Shannon capacity of a cell site using the signal quality distribution for a cell site provided in Alcatel Lucent's Ex Parte Presentation, GN Docket 09-51, February 23, 2010, and then adjusting for multi-user scheduling gains. Our analysis also assumes 43% loss in capacity due to overhead; *see*, for example, *"LTE for UMTS - OFDMA and SC-FDMA Based Radio Access,"* Harri Holma and Antti Toskala (Eds). *See*, for example, *"Fundamentals of Wireless Communications."* *See*, for example, Section 7.7 in *"The Mobile Broadband Evolution: 3G Release 8 and Beyond, HSPA+, SAE/LTE and LTE-Advanced,"* 3G Americas.

19 *See*, for example, Section 7.7 in "The Mobile Broadband Evolution: 3G Release 8 and Beyond, HSPA+, SAE/LTE and LTE-Advanced." 3G Americas.

20 *See*, for example, "LTE for UMTS - OFDMA and SC-FDMA Based Radio Access," Harri Holma and Antti Toskala (Eds).

21 *See*, for example, "The performance of TCP/IP for networks with high bandwidth-delay products and random loss," T. V. Lakshman and U. Madhow, IEEE/ACM Transactions on Networking, June 1997.

22 CDMA operators can choose either LTE or WiMAX for their 4G evolution. LTE currently supports handoffs from CDMA systems.

23 Spectral efficiencies calculated for a (paired) 2x10MHz spectrum allocation for all technologies. Downlink spectral efficiency for WCDMA performance based on 1x1 and 1x2 antenna configurations; HSDPA Rel 5 and HSPA Rel 6 results based on 1x1 and 1x2 configurations, respectively; HSPA Rel 7 performance assumes 1x2 and 2x2 configurations while LTE result assumes 2x2. Uplink spectral efficiencies for WCDMA, HSPA and LTE capacities evaluated for 1x2 antenna configurations. Performance of (3G) EV-DO, which is not shown in the chart, is comparable to (3G) HSPA.

24 CITI BROADBAND REPORT AT 25-28.

25 CITI BROADBAND REPORT AT 8.

26 "HSPA to LTE-Advanced: 3GPP Broadband Evolution to IMT-Advanced (4G)," Rysavy Research/3G Americas, September 2009.

27 Round-trip latencies do not include public Internet latencies. Illustrative latencies for 2G/3G/4G networks; latencies for two networks using the same technology can vary depending on network configuration, infrastructure vendor optimizations, etc.

28 CITI BROADBAND REPORT AT 8.

29 *See*, for example, Figure 9.12 in "LTE for UMTS - OFDMA and SC-FDMA Based Radio Access," Harri Holma and Antti Toskala (Eds); and "LS on LTE performance verification work" at http://www.3gpp.org/FTP/tsg_ran/WG1_RL1/TSGR1_49/Docs/ R1-072580.zip.

30 In terms of cell radius, this gain translates to nearly a three-fold improvement in coverage.

31 *See* also Clearwire Ex-Parte filing, "Mobile broadband link budget example – for FCC", GN Docket No. 09-51 (Nov. 13, 2009) and link budget templates in http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_45/Documents/RP-090740.zip. Both documents perform downlink and uplink link budget analyses for a number of data rates and show that the limiting link budget in each scenario is the uplink.

32 Okumura-Hata is a RF propagation model. *See*, for example, *"Introduction to RF propagation,"* by John Seybold.

33 Using the Okumura-Hata model, we obtain the maximum cell-size at 700MHz to be 12 miles or higher.

34 We chose to classify CTs instead of counties or Census Block Groups (CBG) because counties can be very large and CBGs too small—especially when compared with a typical cell size. Studying the variation over too large an area can lead to picking up terrain effects that are well outside of the cell-coverage area. On the other hand, looking at variations over an area that is too small compared with the desired cell size can lead us to overlooking significant terrain variations that are within the cell coverage area.

35 Based on data provided in Qualcomm Ex-Parte filing, "Mobile broadband Coverage by Technology," GN Docket No. 09-51 (Feb. 22, 2010); Clearwire Ex-Parte filing, "Mobile broadband link budget example – for FCC," GN Docket No. 09-51 (Nov. 13, 2009); "LTE for UMTS - OFDMA and SC-FDMA Based Radio Access," Harri Holma and Antti Toskala (Eds): and link budget templates in http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_45/Documents/RP-090740.zip.

36 Maximum transmit power: fixed CPEs can have higher transmit powers and higher antenna gains through the use of directional antennas and can avoid body losses. Receiver noise figure assumes the use of low-noise amplifiers. Effective noise power is calculated as: Total noise density + 10log10 (Occupied bandwidth), where total noise density = thermal noise density +receiver noise figure = -172dBm/Hz. Required SINR assumes the use of two receive antennas at the base station. Penetration losses can be reduced by fixed CPEs by placing the antennas in ideal locations within the house or outside. MAPL without shadow fading margin is appropriate when using RF planning tools because these tools enable shadowing and diffraction losses due to terrain. Shadow fading margin is required for 90% coverage reliability. MAPL with shadow fading margin is appropriate when using propagation loss models, such as the Okumura-Hata model.

37 RF planning tools by EDX Wireless; see http://www.edx.com/index.html.

38 Propagation loss analysis using RF planning tools takes into account shadowing and diffraction effects due to terrain. So, it is not necessary to include a shadowing margin in the MAPL.

39 Propagation losses due to foliage are ~2-7dB at 700MHz.

40 "PL" denotes propagation loss.

41 Signal quality is the ratio of the received signal strength to the sum of the aggregated interference from other cell sites and thermal noise. This ratio is often called SINR or Signal to Interference and Noise Ratio.

CHAPTER 4 ENDNOTES

42 A *serving* cell site is the cell site that is transmitting the desired data to the end-user. All other cell sites are, then, interfering cell sites.

43 Based on data and analysis provided in: Alcatel Lucent in Ex Parte Presentation, GN Docket 09-51, February 23, 2010; Ericsson in Ex Parte filing, GN Docket 09-51, February 17, 2010; "*The LTE Radio Interface - Key Characteristics and Performance*," Anders Furuskar, Tomas Jonsson, and Magnus Lundevall, Ericsson Research; "LTE-Advanced – Evolving LTE towards IMT-Advanced," Stefan Parkvall, et al, Ericsson Research; "LTE and HSPA+: Revolutionary and Evolutionary Solutions for Global Mobile Broadband," Anil Rao, et al, in Bell Labs Technical Journal 13(4), (2009); "LS on LTE performance verification work," at http://www.3gpp.org/FTP/tsg_ran/WG1_RL1/TSGR1_49/Docs/ R1-072580.zip; 3GPP RAN-1 submission by QUALCOMM Europe, Ericsson, Nokia and Nokia Siemens Networks in 3GPP TSG-RAN WG1 in "Text proposal for TR on system simulation results," http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_53/Docs/R1-082141.zip.

44 *See*, for example: Ericsson in Ex Parte filing, GN Docket 09-51, February 17, 2010; 3GPP RAN-1 submission by QUALCOMM Europe, Ericsson, Nokia and Nokia Siemens Networks in 3GPP TSG-RAN WG1 in "Text proposal for TR on system simulation results," http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_53/Docs/R1-082141.zip; "The LTE Radio Interface - Key Characteristics and Performance," Anders Furuskar, Tomas Jonsson, and Magnus Lundevall, Ericsson Research; "LTE-Advanced -- Evolving LTE towards IMT-Advanced," Stefan Parkvall, et al, Ericsson Research; "LS on LTE performance verification work," at http://www.3gpp.org/FTP/tsg_ran/WG1_RL1/TSGR1_49/Docs/ R1-072580.zip.

45 Based on signal quality distribution data provided by Alcatel Lucent in Ex Parte Presentation, GN Docket 09-51, February 23, 2010. We then determine spectral efficiency for mobile and FWA networks by mapping signal quality to data rates using the method and results published in "LTE Capacity compared to the Shannon Bound," by *Morgensen, et al*, in IEEE 65th Vehicular Technology Conference, 2007.

46 A paired 2x20MHz of spectrum refers to a spectrum allocation where downlink and uplink transmissions occur on two separate 20MHz bands. This is also referred to as Frequency Division Duplex, or FDD, allocation. Note that the total spectrum allocation in this example is 40MHz. Similarly, the total allocation in a paired 2x10MHz of spectrum is 20MHz.

47 When SINR is 0 dB, the power of the signal is equal to the sum of the powers of the interfering signals and noise.

48 MIMO techniques use multiple antennas at the transmitter and receiver to improve spectral efficiency of communication. *See*, for example, "Fundamentals of Wireless Communications," David Tse and Pramod Viswanath, for a detailed exposition.

49 In a system with 2x2 MIMO downlink, both the transmitter (base station) and the receiver (CPE) are equipped with two antennas.

50 For the rest of this section, we shall refer to a "paired 2x10MHz" carrier as simply a 2x10MHz carrier. Thus, for example, a 2x20MHz carrier will imply a "paired 2x20MHz" carrier.

51 Based on results published by QUALCOMM Europe, Ericsson, Nokia and Nokia Siemens Networks in 3GPP TSG-RAN WG1 in "*Text proposal for TR on system simulation results*," http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_53/Docs/R1-082141.zip.

52 *See* "WCDMA 6-sector Deployment - Case Study of a Real Installed UMTS-FDD Network," by Ericsson Research and Vodafone Group R&D, in IEEE Vehicular Technology Conference, Spring 2006; "LTE for UMTS - OFDMA and SC-FDMA Based Radio Access," Harri Holma and Antti Toskala (Eds); "Higher Capacity through Multiple Beams using Asymmetric Azimuth Array," by TenXc wireless, April 2006. The last two references show that 6-sector cells result in an 80% to 90% capacity improvement per cell site.

53 Based on signal quality distribution data provided by Alcatel Lucent in Ex Parte Presentation, GN Docket 09-51, February 23, 2010, and "LTE Capacity compared to the Shannon Bound," by *Morgensen, et al*, in IEEE 65th Vehicular Technology Conference, 2007.

54 "Downlink user data rate" refers to burst rate in a fully utilized network.

55 *See* American Roamer Advanced Services database (accessed Aug. 2009) (aggregating service coverage boundaries provided by mobile network operators) (on file with the FCC) (American Roamer database); see also Geolytics Block Estimates and Block Estimates Professional databases (2009) (accessed Nov. 2009) (projecting census populations by year to 2014 by census block) (on file with the FCC) (Geolytics databases).

56 "Mobile Backhaul: Will the Levees Hold?", Yankee Group, June 2009.

57 Sprint Nextel in Ex Parte Presentation, GN Docket 09-51, January 13, 2010.

58 Level(3) Communications, Notice of Ex Parte Presentation, GN Docket 09-51, November 19, 2009; the filing notes that gigabit links are also available, albeit with limited range; see also "Microwave, Leased Lines, and Fiber Backhaul Deployments: Business Case Analysis."

59 Dragonwave, "Achieving the Lowest Total Cost of Ownership for 4G Backhaul," and "Microwave, Leased Lines, and Fiber Backhaul Deployments: Business Case Analysis."

60 Fiber-to-the-Home Council (FTTH Council), Notice of Ex Parte Presentation, GN Docket 09-51,October 14, 2009, Response to September 22, 2009, FCC Inquiry regarding Broadband Deployment Costs.

61 Dragonwave, "Achieving the Lowest Total Cost of Ownership for 4G Backhaul."

62 Clearwire Ex Parte Presentation, GN Docket 09-51, November 12, 2009 at 12.

63 Ancillary equipment here refers to communication cables, antennas, etc.

64 Average HU density in mountainous and hilly areas is 3 POPs/square mile and 7.4 POPs/square mile, respectively, while in flat areas it is 308 POPs/square mile.

65 Cost and gap shown for counties that have a negative NPV. Recall that the rural cell radius in the 700MHz band can be as much as 57% greater than that at 1900MHz. We chose the cell radius in mountainous areas to be 2 miles as well. In these areas, terrain rather than propagation losses dominate the determination of cell radius; so, it is unlikely that cell sizes will get much smaller than 2 miles.

66 This exhibit supports information and conclusions found in Exhibit 4-Z: Sensitivity of Buildout Cost and Investment Gap to Terrain Classifications.

67 *See* Tower Maps database (Accessed August, 2009) (on file with the Commission).

68 Mobile Satellite Ventures Subsidiary, LLC, Comments, in PS Docket 06-229 at 50 (June 20, 2008). They show that 30% of the sites required to cover 95th percentile of the population in the rural United States are "greenfield;" that number grows to 75% for the 99th percentile. We assume in our model that the number of greenfield sites required is 52.5%, which is the average of those two numbers.

69 Other network costs include those incurred in the Core (Node-0) network as well as on CPE (Node-4) subsidies

70 IDC, United States Consumer Communications Services QView Update, 3Q09, pg. 5, December 2009.

71 United States Telecom Association, Telecom statistics, http://www.ustelecom.org/Learn/TelecomStatistics.html (last visited Feb. 3, 2010). It should be noted that these 1,311 operating companies comprise fewer than 850 holding companies.

72 IDC, United States Consumer Communications Services QView Update, 3Q09, pg. 5, December 2009.

73 *See* Network Dimensioning section below.

74 Adtran -"Defining Broadband Speeds: Estimating Capacity in Access Network Architectures." Submissions for the Record -- GN Docket No. 09-51, (January 4, 2010) at 8.

75 Adtran -"Defining Broadband Speeds: Estimating Capacity in Access Network Architectures." Submissions for the Record -- GN Docket No. 09-51, (January 4, 2010) at 8.

76 Zhone Applications, http://www.zhone.com/solutions/ethernet/, (last visited Nov. 17, 2009).

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78 Letter from Robin Mersh, Chief Operating Officer, Broadband Forum, to Marlene H. Dortch, Secretary, FCC (Jan. 19, 2010) ("Broadband Forum Jan. 19, 2010 Notice of *Ex Parte* Communication – Addendum") at 4.

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80 Broadband Forum Jan. 19, 2010 Notice of *Ex Parte* Communication – Addendum at 10.

81 Comments of National Exchange Carrier Association (NECA) at Table 1, Impact of Middle and Second Mile Access on Broadband Availability and Deployment, GN Docket #s 09-47,09-51,09-137 (filed November 4, 2009).

82 "Current backhaul dimensioning" is based on comments from NECA that on average ~1Mbps is required in the shared portions of the network for every 14.5 users.

83 Comments of National Exchange Carrier Association (NECA) at Table 1, Impact of Middle and Second Mile Access on Broadband Availability and Deployment, GN Docket #s 09-47,09-51,09-137 (filed November 4, 2009).

84 Load coils, which are in-line inductors used as low-pass filters to balance response for voice frequency transmission, effectively block xDSL signals. Load coils generally exist on loops exceeding 18,000 feet.

85 Bridged taps, lengths of unterminated wire typically formed when changes are made to the loop and unneeded cable is left attached to the loop, can cause some service degradation, especially for data services.

86 TCP acceleration is the consolidation of requests for and acknowledgement of data to minimize the number of serial transmissions over communications links. TCP fast-start is the disabling of slow-start, which entails error checking before the link is brought to full speed, in order to provide full link bandwidth from the outset of the session. TCP pre-fetch is the use of the predictive caching of Web content and DNS look-ups.

87 Letter from John P. Janka on behalf of ViaSat, Inc. to Marlene H. Dortch, Secretary, FCC (Jun. 24, 2009) ("ViaSat Jun 24, 2009 *Ex Parte*") at 6.

88 Max Engel, Satellite Today, http://www.satellitetoday.com/via/satellitegetspersonal/Why-ViaSat-Acquired-WildBlue-and-Why-WildBlue-Needed-It_32911.html (last visited Jan. 12, 2010).

89 Peter B. de Selding, Space News, http://www.spacenews.com/satellite_telecom/with-wildblue-acquisition-via-sat-doubles-bet-satellite-broadband.html (last visited Jan.12, 2010).

90 CITI BROADBAND REPORT AT 57.

91 ViaSat Comments at 3.

92 BHOL is the average demand for network capacity across all subscribers on the network during the busiest hours of the network. BHOL is discussed later in the Network Dimensioning section.

93 *See* OBI, Broadband Performance.

94 ViaSat Jan. 5, 2010 *Ex Parte* at 2.

95 Hughes Oct. 26, 2009 *Ex Parte* at 6.

96 See OBI, Broadband Performance.

97 ViaSat Comments in re A National Broadband Plan for Our Future, GN Docket No. 09-51, Notice of Inquiry, 24 FCC Rcd 4342, (2009) at 13.

98 ViaSat Comments in re National Broadband Plan NOI, at 13.

99 ViaSat Comments in re National Broadband Plan NOI, at 3.

100 We assume a growth rate that doubles exactly every three years, i.e. 26.5%, for this analysis.

101 It is unclear what the effect of the Plan will be for satellite broadband providers' subscriber churn due to the buildouts in areas that are currently served only by satellite.

102 ViaSat 2009 Annual Report at 17.

103 ViaSat 2009 Annual Report at 4.

104 Note that the investment gap calculation does *not* exclude NPV-positive counties as the base case does, which explains why the revenue number differs from the $8.9 billion in the base case.

105 Hughes, High-speed Internet Service Plans and Pricing, http://consumer.hughesnet.com/plans.cfm (last visited Mar. 8, 2010).

106 Operational savings are offered by the Point to Point (P2P) and Passive Optical Network (PON) varieties of FTTP, not by the Active Ethernet variety.

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108 CISCO SYSTEMS, FIBER TO THE HOME ARCHITECTURES, 4 (2007), *available* at http://www.ist-bread.org/pdf/FTTP%20Architectures.pdf.

109 Dave Russell, Solutions Marketing Director, CALIX, Remarks at FCC Future Fiber Architectures and Local Deployment Choices Workshop 31 (Nov. 19, 2009).

110 National Exchange Carrier Association Comments in re PN#11 filed (Nov. 4, 2009) at 10.

111 See OBI, Broadband Performance.

112 Dave Russell, Solutions Marketing Director, CALIX, Remarks at FCC Future Fiber Architectures and Local Deployment Choices Workshop 31 (Nov. 19, 2009).

113 Letter from Thomas Cohen, Counsel for Hiawatha Broadband Communications, to Marlene H. Dortch, Secretary, FCC (November 10, 2009) ("Hiawatha Broadband November 10, 2009 *Ex Parte*") at 7.

114 Letter from Thomas Cohen, Counsel for the Fiber to the Home Council, to Marlene H. Dortch, Secretary, FCC (October 14, 2009) ("Fiber to the Home Council October 14, 2009 *Ex Parte*") at 9-10.

115 This equation was derived from fitting a curve to the data, and as such averages over the type of outside plant (aerial or buried). This curve fit may underestimate costs in very high-density areas or other areas with a greater mix of buried infrastructure. The r2 for the curve fit is 0.992 and the R2 adjusted is 0.990.

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117 DOREEN TOBEN, FIBER ECONOMICS AND DELIVERING VALUE, 34 (2006) *available* at http://investor.verizon.com/news/20060927/20060927.pdf.

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119 RVA LLC, FIBER TO THE HOME: NORTH AMERICAN HISTORY (2001-2008) AND FIVE YEAR FORECAST (2009-2013), 7 (2009), http://www.rvallc.com/FTTP_subpage7.aspx.

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124 Broadband Forum Jan. 19, 2010 Notice of *Ex Parte* Communication – Addendum") at 7.

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128 National Cable & Telecommunications Association, Industry Data, http://www.ncta.com/StatsGroup/Availability.aspx (last visited Feb. 3, 2009) and ROBERT C. ATKINSON & IVY E. SCHULTZ, COLUMBIA INSTITUTE FOR TELE-INFORMATION, BROADBAND IN AMERICA: WHERE IT IS AND WHERE IT IS GOING (ACCORDING TO BROADBAND SERVICE PROVIDERS) at 20 (2009) ("CITI BROADBAND REPORT"), *available* at http://www4.gsb.columbia.edu/citi/.

129 National Cable & Telecommunications Association, Industry Data, http://www.ncta.com/StatsGroup/Investments.aspx (last visited Feb. 3, 2009).

130 David Reed, Chief Strategy Officer, CableLabs, Remarks at FCC Future Fiber Architectures and Local Deployment Choices Workshop 31 (Nov. 19, 2009).

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132 This does not mean that every cable operator will offer packages at these speeds, nor that every subscriber will have service at these speeds; instead this is a comment on the capability of the access network for typical user loads. Localized heavy use, e.g., from heavy use of peer-to-peer programs could load the network more than is typical and lead to lower realized speeds.

133 FCC, US spectrum allocation (http://www.fcc.gov/mb/engineering/usallochrt.pdf), (last visited Feb. 19, 2010).

134 ADRIANA COLMENARES et al., DETERMINATION OF THE CAPACITY OF THE UPSTREAM CHANNEL IN CABLE NETWORKS, 3-4, https://drachma.colorado.edu/dspace/bitstream/123456789/74/1/NCS_Spec_031299.pdf, (last visited Feb. 9, 2010).

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157 Consumer-oriented broadband today is provided as a best-effort service whereby the transport network elements are shared among many users. However, business-oriented broadband networks often are sold with service level guarantees that provide performance assurances. As such, last mile as well as the backhaul network elements must be engineered with higher capacity to assure that bandwidth is always available to the subscribers at all times, regardless of network conditions. This adds cost to the transport portions of the networks, which are reflected in much higher prices to the end-users. Business class "dedicated" Internet services have a pricing structure that can be many times more expensive on a cost-per-bit basis.

158 Adtran Ex-Parte Filing: *A National Broadband Plan for Our Future*, GN Docket No. 09-51, (FCC filed 23 February, 2010).

159 While we realize that a typical fully configured DSLAM would likely support no more than ~350 subscribers, we used 500 per the availability of the simulation tool. Assuming that fast Ethernet backhaul is still used for a ~350 subscriber DSLAM would result in an even better oversubscription ratio and even greater probability performance.

160 The results of this analysis do not easily apply to wireless networks. Unlike in other networks, the signal quality or data rate in a wireless network is strongly dependent on the location of the user relative to the cell site. We need to account for this non-uniformity in signal quality to dimension the wireless network [See Wireless Section above.] Still, we note that the spectral efficiency of a Fixed Wireless Access (FWA) network is ~2.35 – 2.7 b/s/Hz. So, the oversubscription ratio of a 3-sector cell site with 2x20 MHz spectrum allocation and 650 subscribers is ~16 – 18.5. Therefore, at first blush, this figure indicates that a FWA network should be able to deliver 4 Mbps in the download with high likelihood. And, as we show in more detail in the Wireless Section above, the FWA network can indeed support this subscriber capacity.

161 The analysis is based on a simulation of N subscribers on a link with capacity C. Specifically, the simulation determines the burst likelihood for the Nth subscriber on the link when the remaining subscribers generate traffic according to a Pareto distribution of mean 160 kbps. Note that the mean of this distribution corresponds to our BHOL assumption of 160 kbps. For more details, *see* Adtran, *Defining Broadband Speeds: Deriving Required Capacity in Access Networks*, at 22, GN Docket No. 09-51, January 4, 2010.

162 Centurylink Ex-Parte filing: *A National Broadband Plan for Our Future*, GN Docket No. 09-51; *International Comparison and Consumer Survey Requirements in the Broadband Data Improvement Act*, GN Docket No. 09-47; *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act*, GN Docket No. 09-137(FCC filed January 22, 2010).

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164 Comments of Kodiak-Kenai Cable Company, LLC. at 5, *A National Broadband Plan for Our Future*, GN Docket # 09-51, PN #11 (FCC filed November 4, 2009).

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168 A subset of the Gabriel network in which the additional constraint is applied that no other points may lie within the area of intersection defined by circles placed at each Gabriel network node with radius equal to the inter-node separation: *available* at: *http://www.spatialanalysisonline.com/output/html/Gabrielnetwork.html*.

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LIST OF COMMON ABBREVIATIONS

3G .... Third generation

4G .... Fourth generation

ADSL................. Asymmetric Digital Subscriber Line

AMPS................ Advanced Mobile Phone Service

ARPU .... Average Revenue per User

AWG .... American Wire Gauge

BHOL................ Busy Hour Offered Load

BPON................ Broadband Passive Optical Network

CAP .... Competitive Access Provider

Capex .... Capital Expenditures

CDMA.............. Code-Division Multiple Access

CLEC .... Competitive Local Exchange Carrier

CO...................... Central Office

CPE .... Customer Premises Equipment

DOCSIS........... Data Over Cable Service Interface Specification

DSL .... Digital Subscriber Line

DSLAM............ Digital Subscriber Line Access Multiplexer

EBITDA........... Earnings Before Interest, Taxes, Depreciation and Amortization

EPON................ Ethernet Passive Optical Network

EV-DO .... Evolution-Data Optimized

FTTN................ Fiber to the Node or Fiber to the Neighborhood

FTTP................. Fiber-to-the-Premise

FW..................... Fixed Wireless

Gbps .... Gigabits per second

GHz .... Gigahertz (1 billion Hertz)

GPON................ Gigabit Passive Optical Network

GSM .... Global System for Mobile communication

HFC................... Hybrid Fiber Coaxial

HFM.................. Hybrid Fiber Microwave

HSDPA .... High Speed Downlink Packet Access

HSUPA .... High Speed Uplink Packet Access

HSPA................ High Speed Packet Access

HU .... Housing Units

Hz .... Hertz

iDEN .... Integrated Digital Enhanced Network

ISP .... Internet Service Provider

kft .... Kilo-feet (1,000 feet)

ILEC .... Incumbent Local Exchange Carrier

IXC .... Interexchange Carrier

kbps .... Kilobits per second

kHz .... Kilohertz (1 thousand Hertz)

LATA................. Local Access and Transport Area

LTE.................... Long-Term Evolution

Mbps .... Megabits per second (1 million bits per second)

MHz .... Megahertz (1 million Hertz)

MIMO.............. Multiple Input, Multiple Output

MSC .... Mobile Switching Center

MSO .... Multiple System Operator

NBP .... National Broadband Plan

NIU .... Network Interface Unit

NPV .... Net Present Value

OECD............... Organization for Economic Co-operation and Development

Opex .... Operating Expenses

OTT .... Over-the-top

POP .... Point of Presence

PON .... Passive Optical Network

POTS .... Plain Old Telephone Service

PSTN .... Public Switched Telephone Network

PV .... Present Value

QAM .... Quadrature Amplitude Modulation

QOS .... Quality of Service

RBOC .... Regional Bell Operation Company

RFoG .... Radio Frequency Over Glass

RT .... Regional Tandem

SG&A .... Selling, General and Administrative expenses

SINR .... Signal to Interference plus Noise Ratio

TDMA .... Time Division Multiple Access

UMTS .... Universal Mobile Telecommunications System

VDSL .... Very high bit rate Digital Subscriber Line

VOIP .... Voice Over Internet Protocol

WCDMA .... Wideband Code Division Multiple Access

WISP .... Wireless ISP

GLOSSARY

4G—Abbreviation for fourth-generation wireless, the stage of broadband mobile communications that will supersede the third generation (3G). Specifies a mobile broadband standard offering both mobility and very high bandwidth. Usually refers to LTE and WiMax technology. For the purposes of analysis in this paper, areas where carriers have announced plans to deliver 4G service are treated as 4G areas; all other areas are treated as non-4G areas.

Access Network—Combination of Last and Second Mile portions of a broadband network. See Last Mile and Second Mile.

Actual Speed—Refers to the data throughput delivered between the network interface unit (NIU) located at the end-user's premises and the service provider Internet gateway that is the shortest administrative distance from that NIU. In the future, the technical definition of "actual speed" should be crafted by the FCC, with input from consumer groups, industry and other technical experts, as is proposed in Chapter 4 of the National Broadband Plan. The technical definition should include precisely defined metrics to promote clarity and shared understanding among stakeholders. For example, "actual download speeds of at least 4 Mbps" may require certain achievable download speeds over a given time period. Acceptable quality of service should be defined by the FCC.

Advanced Mobile Phone Service (AMPS)—A standard system for analog signal cellular telephone service in the United States and elsewhere. It is based on the initial electromagnetic radiation spectrum allocation for cellular service by the FCC in 1970 and first introduced by AT&T in 1983.

American Wire Gauge (AWG)—A U.S. measurement standard of the diameter of non-ferrous wire, which includes copper and aluminum—the smaller the number, the thicker the wire. In general, the thicker the wire, the greater the current-carrying capacity and the longer the distance it can span.

Analog reclamation—In a cable system, refers to repurposing spectrum previously used to carry analog channels for other uses, either digital channels or high-speed data.

[1] The authors provide this glossary as a reader aid. These definitions do not necessarily represent the views of the FCC or the United States Government on past, present or future technology, policy or law and thus have no interpretive or precedential value.

Asymmetric Digital Subscriber Line (ADSL)—A technology that transmits a data signal over twisted-pair copper, often over facilities deployed originally to provide voice telephony. Downstream rates are higher than upstream rates—i.e., are asymmetric. ADSL technology enables data transmission over existing copper wiring at data rates several hundred times faster than analog modems using an ANSI standard.

Average Revenue Per User (ARPU)—A metric used by investors and financial analysts to measure the financial performance of telecommunications service providers. ARPU is the average amount of revenue a company collects from each user per month.

Availability Gap—See Broadband Availability Gap and Investment Gap.

Base Case—The basic set of assumptions that leads to the $23.5 billion Investment Gap. The base case in the model compares the most economical technologies: 12,000-foot-loop DSL and Fixed Wireless. For the 12k-foot-loop DSL, the main assumption is that there is one competing provider in areas that are assumed to receive 4G service, and zero competing technologies in non-4G areas. For Fixed Wireless, costs are allocated to mobile infrastructure in 4G areas; in non-4G areas, all costs are allocated to fixed service, but the carrier is assumed to earn incremental revenue from mobile operations.

Broadband—For the purposes of determining the Investment Gap, 4 Mbps actual download and 1 Mbps actual upload; see also the National Broadband Availability Target.

Broadband Availability Gap—The amount of funding necessary to upgrade or extend existing infrastructure up to the level necessary to support the National Broadband Availability Target. Because this is a financial metric, and to avoid confusion with measures of whether local networks are capable of supporting a given level of broadband service, the Broadband Availability Gap is referred to as the *Investment Gap* throughout this paper.

Broadband Passive Optical Network (BPON)—A type of PON standardized by the ITU-T, offering downstream capacities of up to 622 Mbps and upstream capacities of up to 155 Mbps, shared among a limited number of end users.

Brownfield—A network in which a carrier already has infrastructure in the area that can be used to deliver service going forward.

Burst Rate—The maximum rate or "speed" which a network is capable of delivering within a short timeframe, typically seconds or minutes. This is usually expressed as a rate in Mbps.

Busy Hour Offered Load (BHOL)—BHOL (per subscriber) is the network capacity required by each user, averaged across all subscribers on the network, during the peak utilization hours of the network. Network capacity required is the data received/transmitted by a subscriber during an hour; this can be expressed as a data rate (like kbps) when the volume of data received/transmitted is divided by the time duration.

Capacity—Ability of telecommunications infrastructure to carry information. The measurement unit depends on the facility. A data line's capacity might be measured in bits per second, while the capacity of a piece of equipment might be measured in numbers of ports.

Capital Expenditures (Capex)—Business expense to acquire or upgrade physical assets such as buildings, machinery and in this case telecommunications equipment; also called capital spending or capital expense.

Census Block—The smallest level of geography designated by the U.S. Census Bureau, which may approximate actual city street blocks in urban areas. In rural districts, census blocks may span larger geographical areas to cover a more dispersed population.

Central Office (CO)—A telephone company facility in a locality to which subscriber home and business lines are connected on what is called a local loop. The central office has switching equipment that can switch calls locally or to long-distance carrier phone offices. In other countries, the term *public exchange* is often used.

Churn—The number of subscribers who leave a service provider over a given period of time, usually expressed as a percentage of total customers.

Code-Division Multiple Access (CDMA)—Any of several protocols used in so-called second-generation (2G) and third-generation (3G) wireless communications. As the term implies, CDMA is a form of multiplexing, which allows numerous signals to occupy a single transmission channel, optimizing the use of available bandwidth. The technology is used in ultra-high-frequency (UHF) cellular telephone systems in the 800-MHz and 1.9-GHz bands.

Competitive Access Provider (CAP)—Facilities-based competitive local exchange carriers (CLECs).

Competitive Local Exchange Carrier (CLEC)—The term and concept coined by the Telecommunications Act of 1996 for any new local phone company that was formed to compete with the ILEC (Incumbent Local Exchange Carrier).

Coverage—In wireless communications, refers to the geographic area in which one can obtain service.

Customer Premises Equipment (CPE)—Equipment which resides on the customer's premise. Examples include set top boxes, cable modems, wireless routers, optical network terminals, integrated access devices, etc.

Data Over Cable Service Interface Specification (DOCSIS)—A cable modem standard from the CableLabs research consortium (www.cablelabs.com), which provides equipment certification for interoperability. DOCSIS supports IP traffic (Internet traffic) over digital cable TV channels, and most cable modems are DOCSIS compliant. Some cable companies are currently deploying third-generation (DOCSIS 3.0) equipment. Originally formed by four major cable operators and managed by Multimedia Cable Network System, the project was later turned over to CableLabs.

Digital signal 1 (DS-1)—Also known as T1; a T-carrier signaling scheme devised by Bell Labs. DS-1 is a widely used standard in telecommunications in North America and Japan to transmit voice and data between devices. DS-1 is the logical bit pattern used over a physical T1 line; however, the terms DS-1 and T1 are often used interchangeably. Carries approximately 1.544 Mbps.

Digital Subscriber Line (DSL)—A generic name for a group of enhanced speed digital services generally provided by telephone service providers. DSL services run on twisted-pair copper wires, which can carry both voice and data signals.

Digital Subscriber Line Access Multiplexer (DSLAM)—Technology that concentrates or aggregates traffic in DSL networks. Located in the central office or in a remote terminal.

Discount Rate—The annual percentage rate used to determine the current value of future cash flows.

Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA)—An approximate measure of a company's operating cash flow based on data from the company's income statement. Calculated by looking at earnings, which are calculated by subtracting opex and SG&A from net revenues, before the deduction of interest expenses, taxes, depreciation and amortization. This earnings measure is of particular interest in cases where companies have large amounts of fixed assets which are subject to large depreciation.

Ethernet Passive Optical Network (EPON)—A type of PON standardized by the IEEE, offering downstream capacities of up to 1.25 Gbps and upstream capacities of up to 1.25 Gbps, shared among a limited number of end users.

Evolution-Data Optimized (EV-DO)—A 3G wireless radio broadband data standard that enables faster speeds than are available in existing CDMA networks or other 2G services, such as GPRS or EDGE.

Fast Ethernet (Fast-E)—A network transmission standard that provides a data rate of 100 Mbps.

Fiber—Shorthand for "fiber-optic cable." Fiber-optic cable is the medium associated with the transmission of information as light impulses along a strand of glass.

Fiber to the Node (FTTN)—A high-capacity bandwidth approach that uses both fiber and copper wires. Optical fiber is used from the core of the telco or CATV network to an intelligent node in the neighborhood where copper wire is used for the connection to the end-user, with one node serving perhaps many residences or small businesses. The few 100 meters or so of the local loop from the node to the premises generally is either unshielded twisted pair (UTP) in a telco application or coaxial cable (coax) in an HFC application, although some form of wireless technology is also possible. Known as Fiber to the Neighborhood, or Fiber to the Cabinet (FTTCab), as well.

Fiber-to-the-Premise (FTTP)—A fiber-deployment architecture in which optical fiber extends all the way to the customer's premise. Also known as Fiber to the Home (FTTH) or Fiber to the Building (FTTB). Typically using PON for residential deployments.

Fisher-Pry Model—A mathematical model used to forecast technology adoption when substitution is driven by superior technology where the new product or service presents some technological advantage over the old one.

Fixed Wireless (FW)—Wireless service that uses fixed CPE in addition to (or, possibly, even instead of) mobile portable devices to deliver data services. FW solutions have been deployed as a substitute for wired access technologies. For example, it is being used commercially in the U.S. by Clearwire with WiMAX and Stelera with HSPA, and globally by Telstra with HSPA.

Gabriel Network Topology—An approach to modeling efficient (shortest-route) connections between known network nodes, where the links are determined by making a pairwise comparison of points in the context of the points around them. In a classic Gabriel network, the set of points should not include any co-incident points, that is two points that lie exactly at the same location.

Gigabit Ethernet (Gig-E)—A network transmission standard that provides a data rate of 1,000 megabits per second.

Gigabit Passive Optical Network (GPON)—A type of PON standardized by the ITU-T, offering downstream capacities of up to 2.5 Gbps and upstream capacities of up to 1.25 Gbps, shared among a limited number of end users.

Global System for Mobile communication (GSM)—A second-generation digital mobile cellular technology using a combination of frequency division multiple access (FDMA) and time division multiple access (TDMA). GSM operates in several frequency bands: 400MHz, 900MHz and 1800MHz. On the TDMA side, there are eight timeslots or channels carrying calls, which operate on the same frequency. The standard was jointly developed between European administrations under Groupe Speciale Mobile in the 1980s and introduced commercially in 1991. Unlike other cellular systems, GSM provides a high degree of security by using subscriber identity module (SIM) cards and GSM encryption.

Gompertz Model—A mathematical model used to forecast technology adoption when substitution is driven by superior technology, but purchase depends on consumer choice.

Greenfield—A network in which a carrier has no infrastructure currently (of that technology), and it needs to be built from scratch.

High Speed Packet Access (HSPA)—A family of high-speed 3G digital data services provided by cellular carriers worldwide that uses the GSM technology. HSPA service works with HSPA cell phones as well as laptops and portable devices with HSPA modems. The two established standards of HSPA are HSDPA (Downlink) and HSUPA (Uplink).

Housing Units (HU)—Includes a house, an apartment, a mobile home, a group of rooms or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

Hybrid Fiber Microwave (HFM)—A network (usually wireless) whereby the backhaul transport elements of the network are a mixture or combination of fiber-optic facilities and wireless microwave transport.

Hybrid Fiber Coaxial (HFC)—Another term for cable systems, which are a combination of fiber (Middle and Second Mile) and coaxial cable (Last Mile).

Incumbent Local Exchange Carrier (ILEC)—The dominant local phone carrier within a geographical area. Section 252 of the Telecommunications Act of 1996 defines Incumbent Local Exchange Carrier as a carrier that, as of the date of enactment of the Act, provided local exchange service to a specific area; for example, Verizon, Windstream and Frontier. In contrast, Competitive Access Providers (CAPs) and competitive local exchange carriers (CLECs) are companies that compete against the ILECs in local service areas.

Integrated Digital Enhanced Network (iDEN)—A wireless technology from Motorola combining the capabilities of a digital cellular telephone, two-way radio, alphanumeric pager and data/fax modem in a single network. iDEN operates in the 800 MHz, 900MHz and 1.5 GHz bands and is based on time division multiple access (TDMA) and GSM architecture. It uses Motorola's Vector Sum Excited Linear Predictors (VSELP) voice encoder for voice compression and QAM modulation to deliver 64 kbps over a 25 KHz channel.

Interexchange Carrier (IXC)—A telecommunications service provider authorized by the FCC to provide interstate, long distance communications services and authorized by the state to provide long distance intrastate communications services. An Interexchange Carrier provides, directly or indirectly, interLATA or intraLATA telephone toll services. May be an individual, partnership, association, joint-stock company, trust, governmental entity or corporation engaged for hire in interstate or foreign communication by wire or radio, and between two or more exchanges. Also known as an Interexchange Common Carrier.

Internet Service Provider (ISP)—A company that provides a connection to the public Internet, often owning and operating the Last-Mile connection to end-user locations.

Investment Gap—The amount of funding necessary to upgrade or extend existing infrastructure up to the level necessary to support the National Broadband Availability Target, which is referred to in the National Broadband Plan as the Broadband Availability Gap.

Last Mile—Refers generally to the transport and transmission of data communications from the demarcation point between the end user's internal network and the carrier's network at the customer premise to the first point of aggregation in the carrier's network (such as a remote terminal, wireless tower location, or HFC node).

Levelized—A method, often used in regulatory proceedings, to calculate the annuitized equivalent—i.e., the effective annual value of cash flows—of the costs and revenues associated with building and operating a network. A "levelized" calculation provides a steady cash-flow stream, rather than trying to model or guess the timing of largely unpredictable yet sizable real-world payouts like those for upgrading and repairing equipment. The (net) present value of a levelized cash flow is equal to the (net) present value of actual cash flows.

Link Budget—A calculation involving the gain and loss factors associated with the antennas, transmitters, transmission lines and propagation environment used to determine the maximum distance at which a transmitter and receiver can successfully operate.

Local Access and Transport Area (LATA)—One of 196 local geographical areas in the U.S. created by the Modified Final Judgment in which a divested Regional Bell operating company (RBOC) was permitted to offer exchange telecommunications and exchange access services.

Long-Term Evolution (LTE)—A high performance air interface for cellular mobile communication systems. LTE technology increases the capacity and speed of wireless networks relative to current 3G deployments.

Microwave—Microwave transmission refers to the technique of transmitting information over microwave frequencies, using various integrated wireless technologies. Microwaves are short-wavelength, high-frequency signals that occupy the electromagnetic spectrum 1 GHz to roughly 300 GHz, (typically within ITU Radio Band Signal EHF) though definitions vary. This is above the radio frequency range and below the infrared range.

Middle Mile—Refers generally to the transport and transmission of data communications from the central office, cable headend or wireless switching station to an Internet point of presence.

Mobile Switching Center (MSC)—The mobile switching center (MSC) connects the landline public switched telephone network (PSTN) system to the wireless communication system. The mobile switching center is typically split into a mobile switching center server and a media gateway, and incorporates the bearer independent call control (BICC). The MSC routes the communications to another subscribing wireless unit via a BSC/base station path or via the PSTN/Internet/other network to terminating destination.

Multiple Input Multiple Output (MIMO)—An antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed. MIMO is one of several forms of smart antenna technology, the others being MISO (multiple input, single output) and SIMO (single input, multiple output).

Multiple System Operator (MSO)—Typically refers to a firm that owns more than one cable system, but may refer also to an operator of only one system.

National Broadband Availability Target—The level of service set in the National Broadband Plan that should be available to every household and business location in the U.S. The initial target is an actual download speed of at least 4 Mbps and an upload speed of at least 1 Mbps, with a proposed review and update every four years.

Net Present Value (NPV)—A technique used to assess the current worth of future cash flows by discounting those future cash flows at today's cost of capital. The Net Present Value (NPV) of a project is the total discounted value of all revenues and costs; NPVs greater than zero generate value for a company.

Node—An active or passive element in a cable system where Second-Mile fiber connects with coaxial cable.

Node splitting—In a cable system, adding infrastructure so that subscribers previously served by a single node are moved to multiple nodes, reducing the number of subscribers per node.

Operating Expenses (Opex)—An expense a business incurs over the course of its normal operations. Examples include product overhead, employee salaries and electric bill payments. Importantly, operating expenses on a balance sheet reflect only ordinary expenses rather than unexpected, one-time expenses. One subtracts the operating expense from operating revenue to determine the operating profit.

Organization for Economic Co-operation and Development (OECD)—The 30 member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

Over-the-top (OTT)—Carried over an Internet connection. For example, OTT video would include video delivered by YouTube, Hulu and TV Everywhere.

Passive Optical Network (PON)—A type of Fiber To The Premise (FTTP) network in which unpowered optical splitters are utilized to enable a single fiber to be shared by multiple end users. There are several varieties of PON currently in use in the U.S., including BPON, EPON and GPON, each of which has its own set of standards and capabilities.

Plain Old Telephone Service (POTS)—The basic single line switched access service offered by local exchange carriers to residential and business end users, using loop-start signaling.

Point of Presence (POP)—An access point to the Internet. A point of presence is a physical location that houses servers, routers, switches and aggregation equipment.

Point to point (P2P)—A type of fiber to the premise network in which each endpoint is connected to its serving office via a dedicated fiber optic strand.

Present Value (PV)—The value today of a future payment, or stream of payments, discounted at some appropriate compound discount rate. For example, the present value of $100 to be received 10 years from now using a discount rate equal to 10% interest compounded annually is about $38.55.

Public Switched Telephone Network (PSTN)—The worldwide collection of interconnected public telephone networks that was designed primarily for voice traffic. The PSTN is a circuit-switched network, in which a dedicated circuit (also referred to as a channel) is established for the duration of a transmission, such as a telephone call. This contrasts with packet switching networks, in which messages are divided into small segments called packets and each packet is sent individually. Packet switching networks were initially designed primarily for data traffic.

Quadrature Amplitude Modulation (QAM)—A system of modulation in which data is transferred by modulating the amplitude of two separate carrier waves, mostly sinusoidal, which are out of phase by 90 degrees (sine and cosine). Due to their phase difference, they are called quadrature carriers. Used extensively in cable systems.

Quality of Service (QoS)—The ability to provide different priority to different applications, users or data flows, or to guarantee a certain level of performance to a data flow in a broadband network.

Radio Frequency over Glass (RFoG)—An evolutionary technology that allows cable companies to offer an all-fiber architecture (not hybrid-fiber coax) without changing modulation schemes. RFoG is an SCTE Interface Practices Subcomitee standard in development for Point to Multipoint (P2MP) operations that has a proposed wavelength plan compatible with data PON solutions including EPON and 10G-EPON.

Regional Bell Operation Company (RBOC)—Local exchange carriers formed after the breakup of AT&T in 1984. The seven regional holding companies (RHCs) of roughly equal size were formed as a result of the 1982 Consent Decree AT&T signed with the U.S. Department of Justice, stipulating that it would divest itself of its 22 wholly owned telephone operating companies. The seven RHCs were Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, Southwestern Bell and US West. After a series of acquisitions, mergers and name changes (including one in which a combination of several RHCs reclaimed the original AT&T name), only three of the original seven remain. They are AT&T, Qwest and Verizon. The RBOCs are the incumbent local exchange carriers (ILECs) in their local markets.

Regional Tandem (RT)—A tandem switch is an intermediate switch or connection between an originating telephone call or location and the final destination of the call. These are hub facilities that interconnect telephone central office exchanges and are deployed by geographical region within a telco LATA or exchange.

Remote Terminal—Telephone communications equipment that is installed within the service area or "neighborhood" that traditionally aggregates and multiplexes telephone local loops and transmits the aggregated signals from the service area back to the telephone central office switch. This has evolved to become the "Node" within a service area in a fiber-to-the-node architecture.

Second Mile—Refers generally to the transport and transmission of data communications from the first point of aggregation (such as a remote terminal, wireless tower location, or HFC node) to the point of connection with the Middle Mile transport.

Selling, General and Administrative expenses (SG&A)—Corporate overhead costs, including expenses such as marketing, advertising, salaries and rent. SG&A is found on a corporate income statement as a deduction from revenues in calculating operating income.

Signal to Interference plus Noise Ratio (SINR)—For a wireless communications device, the ratio of the received strength of the desired signal to the received strength of undesired signals (noise and interference).

Spectrum Allocation—The amount of spectrum dedicated (or allocated) to a specific use; in wireless, spectrum allocation is typically made in paired bands, with one band for upstream and the other for downstream.

Spectrum Band—The frequency of the carrier wave in wireless communications. Radios can transmit on different frequencies in the same area at the same time without interfering; frequency marks the division of different parts of spectrum for different uses. Frequency is measured in Hertz (Hz); the range of frequency typically used for radio communications is between 10,000 (10 kHZ) and 30,000,000,000 Hz (30 GHz). Different frequencies have different natural properties: Lower frequencies travel farther and penetrate solids better, while higher frequencies can carry more information (faster data rates, etc.) The best balance of these properties for the purpose of cell phones is in the range of roughly 700-2,500 MHz. A specific range of frequencies allocated for a specific purpose is called a "band."

Switched Digital Video (SDV)—A network scheme for distributing digital video via a cable more efficiently to free up bandwidth for other uses. Only channels being watched by end-users in a given node are transmitted to that node.

Take rate—The ratio of the number of premises that elect to take a service divided by the total number of premises in a market area; effectively a penetration rate of homes passed.

Time Division Multiple Access (TDMA)—Technology used in digital cellular telephone communication that divides each cellular channel into three time slots in order to increase the amount of data that can be carried. TDMA is used by Digital-American Mobile Phone Service (D-AMPS), Global System for Mobile communications (GSM), and Personal Digital Cellular (PDC). Each of these systems implements TDMA in somewhat different and potentially incompatible ways. An alternative multiplexing scheme to FDMA with TDMA is CDMA (code division multiple access), which takes the entire allocated frequency range for a given service and multiplexes information for all users across the spectrum range at the same time.

Universal Mobile Telecommunications System (UMTS)—Third-generation (3G) broadband, packet-based transmission of text, digitized voice, video and multimedia at data rates up to and possibly higher than 2 Mbps, offering a consistent set of services to mobile computer and phone users. Based on the Global System for Mobile (GSM) communication standard.

Unserved—Those housing units without access to a broadband network capable of offering service that meets the National Broadband Availability Target.

Very high bit rate Digital Subscriber Line (VDSL)—A form of DSL similar to ADSL but providing higher speeds at shorter loop lengths.

Voice Over Internet Protocol (VOIP)—A family of transmission technologies for delivery of voice communications over IP networks such as the Internet or other packet-switched networks. Other terms frequently encountered and synonymous with VoIP are *IP telephony*, *Internet telephony*, *voice over broadband* (VoBB), *broadband telephony* and *broadband phone*.

Wideband Code Division Multiple Access (WCDMA)—Another name for UMTS. Also see Universal Mobile Telecommunications System.

Wireless ISP (WISP)—An Internet service provider that provides fixed or mobile wireless services to its customers. Using Wi-Fi or proprietary wireless methods, WISPs provide last mile access, often in rural areas and areas in and around smaller cities and towns. The largest provider of wireless broadband in the U.S. is currently Clearwire Corporation, a WISP that uses an early version of WiMAX to deliver the Internet to customers in the U.S., Ireland, Belgium and Denmark (see WiMAX).

WiMax—Worldwide Interoperability for Microwave Access (WiMAX) is a telecommunications technology that uses radio spectrum to transmit bandwidth between digital devices. Similar to WiFi, WiMAX brings with it the ability to transmit over far greater distances and to handle much more data.

LIST OF TECHNICAL PAPER CONTRIBUTORS

FCC Staff
Primary contributors to the Technical Paper:

Thomas Brown
Mukul Chawla
Robert Curtis
Rohit Dixit
Rebekah Goodheart
Thor Kendall
Kevin King
Thomas Koutsky
Byron Neal
Stagg Newman
Steven Rosenberg
Joseph Soban

The primary contributors are grateful to their colleagues on the Omnibus Broadband Initiative task force and throughout the FCC for their professional support as well as specific feedback that informed the development of this Technical Paper.

Contractors

Model Development, Parameter Analysis, Documentation and Support
Mary Bigner
Arnab Das
Bill Gilli
Sue Jamison
Mary Hilvert
Jim Hines
Ed Honeycutt
Mike Krell
James Stegeman
Robb Stohlman
Ron Williams

Baseline and GIS Analysis
Mark Guttman
Ashley Cassol
Yoonsik Chung
Tim Enderlein
Mark Holmes
Dave Hoover
Brian Jones
Joel McCamley
Pat Payne
Dan Simpson
Jeremy Smith
Paul Sottile
Scott Strom
Karen Vorhees

Statistical Modeling
Don Elliott
Bill Huber
Dick Meyer
Steve Parsons

Operational Cost Development and Support
Carl Hoemke
David Perkins
Gary Hunter
Mike Wilson
Robert Wood
Ruben Miranda
Michelle Madayag

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The Washington Post

The FCC's visible hand

Sunday, March 21, 2010; A18

BY THE Federal Communications Commission's own account, broadband use in the United States has exploded over the past decade: "Fueled primarily by private sector investment and innovation, the American broadband ecosystem has evolved rapidly. The number of Americans who have broadband at home has grown from eight million in 2000 to nearly 200 million last year."

So it is curious that the FCC's newly released National Broadband Plan faults the market for failing to "bring the power and promise of broadband to us all" -- in reality, some 7 million households unable to get broadband because it is not offered in their areas. Such an assessment -- and the call for government intervention to subsidize service for rural or poor communities -- is premature, at best. (Disclosure: The Washington Post Co. has interests in broadcast and cable television and businesses that depend on the Internet, all of which could be affected by FCC action.)

The FCC report, required under last year's stimulus package, equates the campaign for high-speed Internet with the government's earlier efforts to link all American households with telephone service and to subsidize service for the poor through user fees. Broadband has become for many an important staple of everyday life and business, but it is not a necessity akin to telephone service, which provides immediate access to emergency services such as police and fire.

The report also likens the need to build out the "broadband infrastructure" with the past century's push to advance commerce and mobility through creation of the nation's highway system. But broadband networks have been built with billions of dollars from companies in the private sector with a legitimate right to extract profit from well-placed investments. These initiatives -- and yes, the profit motive -- have resulted in remarkable leaps in a few short years. No one can reasonably predict what innovations lie ahead, including those that may make service to rural and poor communities more accessible -- without the need to entice companies with public dollars to service these markets.

To urge government caution is not the same as favoring complete inaction -- and the FCC plan is longer on aspiration than specific policy intentions, so in many areas it's hard to be sure what the agency has in mind. Certainly the FCC is right to monitor information about rates and accessibility and to explore how to make more efficient use of the airwaves. Government subsidies may become essential to fulfill public purposes, such as providing broadband to rural schools. It is useful to continue to mark America's standing in these matters in comparison to that of other nations. But it is hard to see in this field the signs of gross market failure.

Questions for the Record
Communications, Technology, and the Internet Subcommittee
David Villano
National Broadband Plan: Deploying Quality Broadband Services to the Last Mile
April 21, 2010

The Honorable Anna G. Eshoo

1. In 2008, the State of California released its own broadband plan – "The State of Connectivity – Building Innovation Through Broadband." Our National Broadband Plan did not contain a thorough analysis of one of California's concepts, the use of "Smart Housing Policies" to encourage and/or require that all publicly-subsidized housing under construction or rehabilitation provide affordable broadband to all residents. Shouldn't we have HUD explore these concepts to better reach lower income and disadvantaged populations during the broadband rollout process?

   Response: RUS supports the concept of lower income and disadvantaged populations having access to affordable broadband service. In rural apartments financed by USDA's Rural Housing Service, the Department encourages the availability of broadband service throughout the apartment complex and in its community centers.

2. I've long supported the idea of a free wireless broadband network, financed in part by commercials. I know that there is spectrum available for this purpose and there is a proposal outstanding to develop this idea. I would like to hear from the panelists today concerning their viewpoints on this issue: do you believe that a free broadband wireless lifeline can resolve some of the communications issues facing our hardest to reach populations? What other ideas do you support to reach the level of inclusiveness that will hook everyone up at the last mile?

   Response: RUS supports ubiquitous broadband service for all Americans. The idea of a free wireless broadband network is an interesting concept which is considered in the FCC's recently released National Broadband Plan.

The Honorable Cliff Stearns

1. What assurance can you provide the committee that RUS will have awarded and obligated all Recovery Act funds for BIP by September 30?

   Response: , RUS is aware of the logistics of delivering large loan & grant programs within limited time constraints similar to that of the Recovery Act. RUS has developed aggressive timelines and contingency plans to ensure all funds are obligated by September 30, 2010. Moreover, the agency has designed a satellite program to quickly expend unused funds to provided broadband service to rural premises that remain unserved after the all Last Mile and Middle Mile projects are awarded. Under Notice of Funding Availability (NOFA) II, RUS received 776 applications totaling approximately $11.2 billion. We are pleased to report that RUS is on track to obligate all awards under NOFA II no later than September 30, 2010.

2. Of the 68 awards announced in the first round of funding, how many of those projects have actually broken ground and begun to draw down funds?

   Response: RUS is still in the process of closing many of the awards announced under the first round of funding. Many awardees have started the process of obtaining permits and securing contractors. In addition, RUS is scheduling workshops with awardees to discuss the build-out process and introduce awardees to our Field Accountants and General Field Representatives that will be overseeing the build-out of these projects. In addition, we will be providing sessions on integrating these projects with rural economic business strategies to ensure continuous project sustainability. To date, though our awardees have not begun to draw down funds, we expect construction to begin early this summer.

3. Some stakeholders have criticized the second round public review process. For example, RUS has posted an application directory on broadbandusa.gov with all the applications received for RUS funding. However, this information does not contain an executive summary and so incumbent providers may not have enough detail to evaluate a

proposal to bring broadband service to a specific area. What steps are underway to ensure that the public review process is fair, transparent, and allows for sufficient information and time for incumbent providers to submit comments?

Response: On April 16, 2010, RUS posted a searchable database of all applications which included a project summary for each application at www.broadbandusa.gov. On April 23, 2010, RUS also posted the proposed service territory maps of all applicants under NOFA II on: www.broadbandusa.gov together with instructions on how incumbent service providers can provide comments on their existing service territory, which would be used in determining whether the applicant's proposed service territory meets the NOFA requirements. Incumbent service providers were given 30-days from April 23rd to submit comments. We believe this process is fair, transparent and provides sufficient information for incumbents to submit comments.

4. Please describe current plans for oversight. What plans do you have to either hire additional personnel, or use existing staff, to ensure proper oversight of program recipients after the September 30 program funding deadline?

   Response: Rural Development has decades of experience in responsibly managing multiple loan and grant programs. In our telecommunications programs, we maintain a default rate of less than one percent. To deploy resources under the Recovery Act, Rural Development hired temporary staff and a contractor to assist us with application processing. Our goal is to ensure that field resources are available throughout the build-out phase so that taxpayer's resources are wisely invested. We also have included contract services beyond September 30th for oversight of these projects. Collectively, with existing Rural Development staff, we are confident that we can provide proper oversight of program recipients.

5. What are the main lessons learned from the first round NOFA and how have those lessons been applied to the second funding round?

   Response: There are a number of lessons RUS learned under our first NOFA. All of these lessons have been applied under NOFA II, including the following changes:

- The first NOFA was published jointly by RUS and NTIA. The NOFA required that all "rural" applications had to be filed with RUS or jointly with RUS and NTIA. Both RUS and NTIA received comments from the public and Congress over the "joint" application process. Comments also indicated concern that NTIA offered an 80 percent grant product and RUS offered either a 100 percent grant product for "remote" rural areas or 50/50 loan/grant product for non-remote areas.

- In the second round, RUS and NTIA published separate but coordinated NOFAs. Applicants could only apply to one program (BTOP or BIP). In addition, RUS offered only one BIP product, which is a 75/25 grant/loan combination with incentives for higher loan components.

- For the second NOFA, RUS eliminated the separate funding bucket for "remote" projects. Instead, RUS offered higher points for projects in the most rural areas and has the flexibility to increase the standard 75 percent grant to a 100 percent grant for the most rural areas and those areas with lower density, low median income, and high unemployment.

- In the second NOFA, RUS focused on Last Mile projects, which are urgently needed in many rural communities and which directly connect homes, businesses and key community anchor institutions. For Middle Mile projects, RUS strongly encouraged projects from current RUS borrowers and grantees.

- The second NOFA also provides for a "second review" process to allow RUS additional flexibility and the ability to conduct reviews of meritorious applications which meet Recovery Act objectives. For example, should there be an insufficient number of high-scoring applications in the initial review process, RUS can elect a "second review" of worthy applications.

- RUS may also accept an application from NTIA which it cannot fund but appears meritorious under RUS's BIP program.

- The RUS Administrator is authorized to add points to scores for projects that provide significant assistance to essential community facilities, promote rural economic development, and support persistent poverty counties or chronically underserved areas.

- RUS received many comments on how to improve the application process. As a result, the agency streamlined the process by eliminating the two-step application and the requirement to list all Census blocks in the application, which is now done by RUS's mapping tool.

- In the second NOFA, RUS changed the definition of eligible service areas. As a result, any rural area where at least 50 percent of the premises lack access to broadband service at the rate of 5 Mbps (upstream and downstream combined) will qualify for funding. RUS has determined that these areas lack high speed broadband service sufficient to facilitate rural economic development as required by the Recovery Act. Service offerings must still be within proposed funded service areas which are at least 75 percent rural as required by the Recovery Act.

- Additional funding opportunities will be offered to ensure the long term benefits of BIP in rural America. The second NOFA allows satellite providers to compete for approximately $100 million to provide broadband services to rural customers that remain unserved after all Recovery Act Last Mile and Middle Mile awards are made.

  BIP award recipients under the first NOFA and applicants under the second NOFA can also apply for Technical Assistance grants for the development of a regional economic development plan focusing on broadband. This will further broadband deployment and rural economic development beyond projects funded by the Recovery Act. Indian Tribes, whether or not they are awardees under either the first NOFA or applicants under the second NOFA, are also eligible to apply for the Technical Assistance grants.

Awardees under either NOFA are also eligible for grant funds to provide broadband connectivity to rural libraries funded by Rural Development's Community Facilities program.

Beyond the Recovery Act, RUS plans to use the lessons learned under both NOFA's to enhance our existing broadband and telecommunications programs.

HENRY A. WAXMAN, CALIFORNIA
CHAIRMAN

JOE BARTON, TEXAS
RANKING MEMBER

ONE HUNDRED ELEVENTH CONGRESS

Congress of the United States

House of Representatives

COMMITTEE ON ENERGY AND COMMERCE
2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6115

Majority (202) 225-2927
Minority (202) 225-3641

May 11, 2010

Joe Garcia
Regional Vice President
National Congress of American Indians
1516 P St NW
Washington, DC 20005

Dear Mr. Garcia:

Thank you for appearing before the Subcommittee on Communications, Technology, and the Internet on April 21, 2010, at the hearing entitled "The National Broadband Plan: Deploying Quality Broadband Services to the Last Mile."

Pursuant to the Committee's Rules, attached are written questions for the record directed to you from certain Members of the Committee. In preparing your answers, please address your response to the Member who submitted the questions.

Please provide your responses by May 25, 2010, to Earley Green, Chief Clerk, via e-mail to Earley.Green@mail.house.gov. Please contact Earley Green or Jennifer Berenholz at (202) 225-2927 if you have any questions.

Sincerely,

Henry A. Waxman
Henry A. Waxman
Chairman

Attachment

The Honorable Anna G. Eshoo

1. In 2008, the State of California released its own broadband plan – "The State of Connectivity – Building Innovation Through Broadband." Our National Broadband Plan did not contain a thorough analysis of one of California's concepts, the use of "Smart Housing Policies" to encourage and/or require that all publicly-subsidized housing under construction or rehabilitation provide affordable broadband to all residents. Shouldn't we have HUD explore these concepts to better reach lower-income and disadvantaged populations during the broadband rollout process?

2. I've long supported the idea of a free wireless broadband network, financed in part by commercials. I know that there is spectrum available for this purpose and there is a proposal outstanding to develop this idea. I would like to hear from the panelists today concerning their viewpoints on this issue: do you believe that a free broadband wireless lifeline can resolve some of the communications issues facing our hardest to reach populations? What other ideas do you support to reach the level of inclusiveness that will hook everyone up at the last mile?

The Honorable Cliff Stearns

If the broadband plan's analysis is anywhere near correct that 95 percent of the country has access to broadband and two-thirds subscribe, that means that broadband is available to the overwhelming majority of the country. The government has limited resources and we should make every tax-payer dollar count. It is important that the FCC and Congress engage in a cost-benefit analysis when deciding what aspects of the broadband plan to implement and how. Is it better to spend money and focus government efforts in areas of the country that don't have access to broadband, such as Tribal lands and other high-cost areas that are uneconomic for the private sector to serve, before areas that do have broadband?

National Congress of American Indians

May 25, 2010

Hon. Henry A. Waxman
Chairman
Committee on Energy and Commerce
U.S. House of Representatives
2125 Rayburn HOB
Washington, DC 20515-6115

Re: Response to Questions Regarding
The National Broadband Plan:
Deploying Quality Broadband Services
To the Last Mile

Dear Chairman Waxman:

Thank you for providing the National Congress of American Indians (NCAI), through Joe Garcia, Regional Vice President, the opportunity to testify before the Subcommittee on April 21, 2010, and for your follow up letter of May 11, 2010, conveying additional questions from several Subcommittee members. On behalf of NCAI, we are providing our responses to those questions.

From The Honorable Anna G. Eshoo

1. In 2008, the State of California released its own broadband plan – "The State of Connectivity – Building Innovation Through Broadband." Our National Broadband Plan did not contain a thorough analysis of one of California's concepts, the use of "Smart Housing Policies" to encourage and/or require that all publicly-subsidized housing under construction or rehabilitation provide affordable broadband to all residents. Shouldn't we have HUD explore these concepts to better reach lower income and disadvantaged populations during the broadband rollout process?

NCAI welcomes the support of all agencies of the federal government in ensuring that all Americans have access to obtainable, reliable, and affordable broadband. We believe that it is important to work with individual agencies, such as HUD, to guarantee tribes are able to access broadband and make sure FCC standards are followed. Creative solutions are needed and if HUD should be given the task of exploring how affordable broadband could better be deployed, NCAI and its member nations stand ready to work closely in a supportive relationship that will transform the government-to-government consultative process.

Having participated in the FCC's National Broadband Plan (NBP) proceeding, however, NCAI fully recognizes the highly technical nature of this debate. The FCC clearly is the "expert agency" in this area. The FCC's NPB Team listened to us, and we believe, now understands the particular issues facing Indian Country in leaping the Digital Divide. As

Joe Garcia testified, the FCC understands what a "Tribal-centric deployment model" and "core community institutions" are all about. The FCC also is beginning to grasp that fact that just because broadband may be theoretically available on tribal lands, that is a far cry from a tribal member being able to walk into a local shop, sign up for broadband, and actually receive the promised service at the advertised price and ***actual*** speed advertised.

In fact, even the term "broadband" is open to interpretation. NCAI is concerned that were HUD given a mandate to ensure that broadband is available in all future public housing projects, what might result is a flavor of broadband that falls short of the basic needs of users. Without technical expertise on critical issues, HUD may inadvertently do more harm than good by adding broadband as a requirement to public housing builders. For instance, could a builder merely place a single satellite dish on a large Multiple Dwelling Unit (MDU), slice up the connection to 100 users and call that broadband, since at the rooftop there is a broadband connection? Would HUD have the necessary expertise to establish clear-cut policies and the "boots on the ground" to ensure that affordable and reliable broadband was available for each unit?

From the viewpoint of NCAI, the establishment of the FCC's new Office of Tribal Affairs provides the first, and best, vehicle for the government-to-government coordination between the federal government and the 565 federally recognized tribes that will be required to make sure that Indian Country is not left behind in the race to deploy broadband across the United States. Congress should increase funding for the FCC's Indian Telecommunications Initiatives (ITI) to address just this sort of development and others. As part of the NBP, the FCC recommended that the Executive Branch establish a Federal-Tribal Broadband Initiative, "through which the federal government can coordinate both internally and directly with tribal governments on broadband-related policies, programs and initiatives." NBP, p. 184 (Recommendation 9.14). Broadband in public housing would be one such issue where FCC's lead through the Federal-Tribal Broadband Initiative could help avoid the potential problems outlined above.

If HUD is brought into the mix, its Office of Native American Programs (ONAP) must be given the similar authority and jurisdiction as the FCC's Office of Tribal Affairs, and the two must effectively coordinate and consult with the tribes. HUD and ONAP will need to come up to speed quickly on the unique issues facing Indian Country, or their participation in this process, which is time critical, will only bog down the process, not facilitate quicker or better deployment in Indian Country.

NCAI will work with HUD and other federal agencies to make sure tribal needs are met and that all broadband services are received in a timely and efficient manner. We are open to solutions that will bring affordable and dependable service to all of Indian Country.

2. I've long supported the idea of a free wireless broadband network, financed in part by commercials. I know that there is spectrum available for this purpose and there is a proposal outstanding to develop this idea. I would like to hear from the

panelists today concerning their viewpoints on this issue: do you believe that a free broadband wireless lifeline can resolve some of the communications issues facing our hardest to reach populations? What other ideas do you support to reach the level of inclusiveness that will hook everyone up at the last mile?

The concept of free wireless broadband financed in part by commercials is facially appealing. Advertising fueled the deployment of broadcasting services (first radio, then television) across America. Yet with that model, Indian Country was left out of the mix. It took the FCC nearly 80 years to wake up to the fact that advertiser supported media failed to deliver broadcasting services to the native nations. Only with the newly adopted Tribal Priority, which recognizes the sovereign rights and duties of the 565 federally recognized tribes to provide for their people, will many tribal nations have an opportunity to bring broadcasting services to Native Americans.

Does the same fate await Indian Country with advertiser supported broadband network? Will it take 80 years before Congress and the FCC realize that the advertisers are only interested in densely populated areas with affluent users? The ultimate in "red lining" could result if Congress and the FCC rely on advertisers to fund deployment to rural areas. The developments of the past several years provide the basis for and reinforce what NCAI told the FCC in the course of its development of the NBP, "Tribal-centric" models for broadband development have the greatest opportunity for success. A nationwide "one-size fits all" approach finds its fewest justifications in Indian Country, often where sustainability must be achieved before profitability can be contemplated. With over 565 Tribal nations, each with its own unique needs to develop its own broadband economy, one size fits none.

NCAI is also concerned about advertising content. Who will regulate what tribal members are subjected to? Will Native Americans have to listen to alcohol advertising before they can access their business e-mail accounts? Will the same ring-tone scams that plagued Facebook a few months ago dupe Native Americans into signing up for fake services? As sovereign entities charged with the well being of their members, NCAI has grave concerns about a proposal that places a time and content barrier in front of people before they can access vitally needed services over the Internet.

In your question, you indicate that spectrum may be available for broadband deployment using the advertiser-supported model. NCAI would like to take this opportunity to further discuss the spectrum needs of tribes. Very little of the spectrum that could deliver broadband services to Indian Country is in the hands of tribes, tribal-controlled entities, or even outside entities that understand the unique needs of Indian Country. Instead, much of it has gone, on a nationwide basis, to the highest commercial bidder. As a result, while there is significant spectrum available in Indian Country, much of it lies fallow, as communications carriers have not figured out how to make it profitable with their traditional residentially-driven deployment models. If this fallow spectrum (some of it unlicensed, some of it licensed) could be recaptured and relicensed to tribes, it could be redeployed using a tribal-centric model which focuses first on delivering services to core tribal (and federal) institutions, with residential deployment following after sustainability is demonstrated. Tribes who have become their own carriers have shown great success with this deployment model, with the end result that tribal members have broadband access through these institutions and Chapter Houses for the first time. Not only is this model sustainable, it also builds tribal broadband economies.

This redeployment is also possible because of the distinct geographic locations inhabited by the 565 federally recognized Tribes. Engineering solutions for redeployment are achievable for most, if not all, of Indian Country. NCAI is hopeful that the FCC's "Dashboard 2.0" project, which is mapping not only theoretical availability of broadband, but also actual spectrum use, will shed a bright light on the amount of spectrum that could be used for broadband deployment in Indian Country, but is silent because tribes do not fit nicely into commercial carriers' deployment models.

Given the choice between a "free" broadband connection run by outsiders who both control the pipe and the content that tribal members would have to slog through before getting to the Internet, and a broadband deployment model that helps build a sustainable knowledge-based broadband economy, NCAI believes most tribes would choose the latter, and control their own futures.

Careful consultation with tribes will be required to convince them that such a plan would actually work, and would likewise be in their best interests. While NCAI is wary of such a plan, it remains willing to consult with the federal government on how such a system could be put in place.

From The Honorable Cliff Stearns

If the broadband plan's analysis is anywhere near correct that 95 percent of the country has access to broadband and two-thirds subscribe, that means that broadband is available to the overwhelming majority of the country. The government has limited resources and we should make every tax-payer dollar count. It is important that the FCC and Congress engage in a cost-benefit analysis when deciding what aspects of the broadband plan to implement and how. Is it better to spend money and focus government efforts in areas of the country that don't have access to broadband, such as Tribal lands and other high-cost areas that are uneconomic for the private sector to serve, before areas that do have broadband?

NCAI agrees that places without broadband access or with very high costs of deployment should be of highest priority in terms of future broadband deployment. NCAI disagrees, however, with the 95 percent availability assumption. Indian Country has learned firsthand the difference between theoretical ability, and the ability of a tribal member to be able to walk into a local shop, sign up for broadband, and actually receive the promised service at the advertised price and ***actual*** speed advertised. Promise and practice are two different things.

Tribal nations and communities are also in critical need of robust broadband services which can serve as the backbone for economic development opportunities. Broadband has the ability to be the great leveler of many historic past wrongs that resulted in tribal nations being marginalized to the remote unserved areas of the country.

To declare that any particular tribal nation has access to broadband because, for example, a carrier claims to provide service, runs the risk that the FCC or other agency will declare victory and move on, while the tribe comes to realize that the service is either not really available, or not reliable, or not affordable. NCAI supports the efforts of the FCC to better gauge the availability of actual broadband deployment through its "Dashboard 2.0" program, and is working to engage more tribes to participate in that program. Of course, engaging tribes without any access to broadband now to gauge what broadband is available is a bit oxymoronic.

That is where the FCC's Office of Tribal Affairs and the proposed Tribal Broadband Fund can play a key element in assisting tribes with technical expertise and funding to participate in this process and recognize the difference between actual reliable and available robust broadband services robust enough to grow a healthy sustainable economy, and that which is not.

But tribal broadband economies cannot be grown without access to spectrum. NCAI is hopeful that the FCC's "Dashboard 2.0" project, which is mapping not only theoretical availability of broadband, but also actual spectrum use, will shed a bright light on the amount of spectrum that could be used for broadband deployment in Indian Country, but is silent because tribes do not fit nicely into commercial carriers' deployment models.

Very little of the spectrum that could deliver broadband services to Indian Country is in the hands of tribes, tribal-controlled entities, or even outside entities that understand the unique needs of Indian Country. Instead, much of it has gone, on a nationwide basis, to the highest commercial bidder. As a result, while there is significant spectrum available in Indian Country, much of it lies fallow, as communications carriers have not figured out how to make it profitable with their traditional residentially-driven deployment models. If this fallow spectrum (some of it unlicensed, some of it licensed) could be recaptured and relicensed to tribes, it could be redeployed using a tribal-centric model which focuses first on delivering services to core tribal (and federal) institutions, with residential deployment following after sustainability is demonstrated. Tribes who have become their own carriers have shown great success with this deployment model, with the end result that tribal members have broadband access through these institutions and Chapter Houses for the first time. Not only is this model sustainable, it also builds tribal broadband economies.

Congress should recognize, develop and fully fund a key element of the National Broadband Plan as it relates to tribal nations which is essential to finding and developing these sustainable broadband models in Indian Country, namely the Tribal Broadband Fund. Congress should also increase funding the Indian Telecommunications Initiatives programs of the FCC's new Office of Tribal Affairs to bring that program up to speed with the many broadband related opportunities for training, outreach and consultation.

Best regards,

Jacqueline Johnson-Pata
Executive Director

ViaSat

6155 El Camino Real
Carlsbad, CA 92009-1602
Tel: (760) 476-2200
Fax: (760) 929-3941

May 25, 2010

The Honorable Anna G. Eshoo
Member, House of Representatives
205 Cannon Building
Washington, DC 20515

Re: Subcommittee on Communications, Technology, and the Internet Hearing "The National Broadband Plan: Deploying Quality Broadband Services to the Last Mile"

Dear Representative Eshoo:

I am writing in response to the questions you submitted in connection with my testimony before the Subcommittee on Communications, Technology, and the Internet on April 21, 2010.

Question 1: *I've long supported the idea of a free wireless broadband network, financed in part by commercials. I know that there is spectrum available for this purpose and there is a proposal outstanding to develop this idea. I would like to hear from the panelists today concerning their viewpoints on this issue: do you believe that a free broadband wireless lifeline can resolve some of the communications issues facing our hardest to reach populations? What other ideas do you support to reach the level of inclusiveness that will hook everyone up at the last mile?*

Response:

To be sure, the universal service goals of a free wireless broadband program are commendable. When the concept of free broadband has been tried in the marketplace before, however, it has not been commercially successful. Moreover, some of the "hardest to reach" — financially disadvantaged and rural Americans — will not likely be the prime targets of the advertisers who would support such a network. In addition, the network would be used heavily by the very people who can afford broadband service, and advertisers would likely cater to the needs of those individuals. Network use would likely be weighted toward video entertainment services, rather than "lifeline" service for those most in need. Any efforts to constrain use for video entertainment purposes could conflict with network neutrality requirements. And there is a significant risk that the networks would not remain viable, in any event, without government subsidies which, in turn, could distort or significantly inhibit competition from other networks. I do believe there is another solution.

I firmly believe that privately funded infrastructure will be in place, within a decade, to make 4/1 Mbit/s service, or better, available to all unserved households. Satellite broadband systems, including the system in which ViaSat is investing over $1 Billion, will play a critical role in reaching those households. We'll offer a competitive, quality service to everyone at market rates.

I realize that all Americans may not be able to afford broadband at "market" rates, and that the cost of service may prevent adoption. As my written testimony reflects, I'd much rather see government subsidies used for that purpose — facilitating broadband adoption by those who could not otherwise afford service. Problems like that are where broadband subsidies would be more properly focused, rather than on constructing one particular type of infrastructure or technology. Broadband subsidies would be most effective, and least market disruptive, if they were designed similar to the way other entitlement programs have been created to aid disadvantaged Americans in areas such as food stamps, health care, child care, or other areas identified by Congress. Privately funded industry provides the service, and the government helps people in need obtain those goods and services.

Getting help to those in need should be the primary goal of any government subsidy program. As noted above, with respect to free wireless broadband service, I'm very concerned that the effectiveness of the subsidies that might be used to support such a service would be highly diluted by use of the system by others than those in need. In that case, any subsidies would end up being absorbed by people who can already afford broadband.

In contrast, an entitlement program could be designed to foster sustainable broadband adoption by disadvantaged citizens. Such a "where it's needed" program would result in more people being served, and served faster, than the existing broadband subsidy programs. If satellite broadband were eligible for such a program, we would be able to serve disadvantaged Americans with a quality service starting next year. And we could reach as many disadvantaged Americans as Congress may identify even sooner than the FCC's 10 year horizon in the National Broadband Plan.

Any such subsidy programs must be open, transparent, and provide for enduring competition. As an initial matter, any programs should be truly technology neutral. They also should be firmly routed in the principle of consumer choice. As long as a service meets an objective standard, consumers should be empowered to choose from a number of qualified broadband services, and pick the one that provides the best value for their individual needs. Ensuring market-based competition for the business of those consumers is the best way to use limited tax dollars in the most cost effective manner. I am convinced that satellite broadband will provide the best value for many consumers, if we can compete on a fair and level playing field.

Question 2: *I'm also a proponent of "dig once" infrastructure projects. I've heard from Secretary LaHood and Chairman Genachowski that they support his concept and it is included in the National Broadband Plan as a way to reach the last mile generally, and especially in hard to reach regions like Indian Reservations. Would each of the panelists give me their perspectives on how this type of program can facilitate their industries or reach underserved and unserved populations?*

Response:

The coordinated efforts, minimized disruption, and potential cost efficiencies exemplified by "dig once" infrastructure projects certainly are attractive. Still, we need to be careful that such programs do not become the source of competitive abuses by the incumbent providers who may first enjoy the benefits of those programs. Among other things, such programs would need to ensure fair and equitable access by new and innovative technologies. And we also should ensure that those programs do not result in government subsidization of broadband deployment by one set of providers. Doing so could distort or significantly inhibit competition, because if only one entity receives government dollars, that subsidy would provide a financial edge over its competitors.

Please let me know if you have any further questions or if I can assist you or your staff in exploring these important issues.

Sincerely yours,

Mark Dankberg
Chairman and CEO

ViaSat

6155 El Camino Real
Carlsbad, CA 92009-1602
Tel: (760) 476-2200
Fax: (760) 929-3941

May 25, 2010

The Honorable Cliff Stearns
Member, House of Representatives
205 Cannon Building
Washington, DC 20515

Re: Subcommittee on Communications, Technology, and the Internet, Hearing "The National Broadband Plan: Deploying Quality Broadband Services to the Last Mile"

Dear Representative Stearns:

This letter responds to the question you submitted in connection with my testimony before the Subcommittee on Communications, Technology, and the Internet at the hearing on April 21, 2010.

Question 1: *You indicated at the hearing that if we subsidize roll-out of wireline broadband to high-cost parts of the country, it harms the ability of satellite providers to offer broadband by making it harder for you to compete with the subsidized rates. If none of your competitors received subsidies, would you need subsidies? Are there any places in the country you could not offer service if you received no subsidies?*

Response:

As reflected in my testimony, subsidies are not required to construct broadband infrastructure to reach the households that are unserved today. Over the next decade, I firmly believe that privately funded infrastructure will be in place to make available 4/1 Mbit/s service, or better, to all such households, and that satellite broadband systems, including the system in which ViaSat is investing over $1 Billion, will play a critical role in reaching those households. Satellite broadband can reach any place in the country — in the same way that satellite TV is available anywhere and everywhere in the US today. And, as my testimony reflects, satellite can in fact serve all of those unserved households.

For that reason, government funding should not be used to subsidize the construction, upgrade, or operation of broadband infrastructure (whether new infrastructure, or existing infrastructure) merely to make 4/1 Mbit/s service available at market competitive prices. Where users can receive a quality broadband service at market rates and in a timely fashion, there is no "market failure," and there is no broadband deployment problem to solve. In fact, using government funds to subsidize broadband deployment or operation in those cases could distort or significantly inhibit competition. The reason is simple — if one competitor receives government dollars, the subsidy provides a financial edge, and places all other companies, including those that would otherwise not require subsidies, at a competitive disadvantage. Or, at the very least, subsidies that go to other competitors would destroy or diminish the competitive advantages that more cost effective companies have created through careful and prudent investments and R&D efforts. The effect of the market distortion can be particularly severe in cases where the government excludes one technology from participating in the same program in which competing technologies may participate. And market forces are precisely why you see companies, such as ours, applying for funding under the current broadband deployment programs — a responsible Board of Directors cannot allow a company to sit idly while its competitors gain a competitive edge with government funding. In fact, I would say that the threat that the government may subsidize otherwise less cost effective competing technologies, and grant them funds that are much, much greater than we would require is probably the single most significant obstacle to raising the investment capital needed to reach the unserved population even more quickly, and with a higher level of service. Competing with the government is a significant extra hurdle in raising investment capital.

The effects subsidies can have on a competitive marketplace are the reason why it is critical that subsidy programs, if they are used at all, be technology neutral, both on paper and in practice. Unfortunately, satellite technology has not been eligible to participate in broadband subsidy programs to the same extent as other technologies, even though satellite can deliver a competitive quality of service, and can do so on a more cost-effective basis than any other technology. We've just been written out of the existing programs. That is not what Congress intended, and it is not right.

I hope these historical biases get fixed as Congress focuses on universal service reform. I do believe that there may be legitimate uses for government subsidies, particularly when the policy goal is getting broadband service to those who could not otherwise afford it. As my written testimony recognizes, there are disadvantaged Americans who may not be able to afford broadband service, even though service may be available at market competitive rates. Problems like that are where broadband subsidies would be more properly focused, rather than on constructing one particular type of infrastructure or technology. Broadband subsidies would be most effective, and least market disruptive, if they were designed similar to the way other entitlement programs have been created to aid disadvantaged Americans in areas such as food stamps, health care, child care, or other areas identified by Congress. Privately funded industry provides the service, and the government helps people in need obtain those goods and services.

Any such subsidy programs must be open, transparent, and provide for enduring competition. They also should be firmly routed in the principle of consumer choice. As long as a service meets an objective standard, consumers should be empowered to choose from a number of qualified broadband services, and pick the one that provides the best value for their individual needs. Ensuring market-based competition for the business of those consumers is the best way to use limited tax dollars in the most cost effective manner. I am convinced that satellite broadband will provide the best value for many consumers if we can compete on a fair and level playing field.

Please let me know if you have any further questions or if I can assist you or your staff in exploring these important issues.

Sincerely yours,

Mark Dankberg
Chairman and CEO

Written Response to Follow up Questions of Mr. Austin Carroll, General Manager of Hopkinsville Electric System in Hopkinsville, Kentucky, on behalf of the American Public Power Association

To Representative Anna Eshoo (D-CA)

The National Broadband Plan: Deploying Quality Services in the Last Mile

Wednesday, April 21, 2010

Representative Eshoo, thank you for allowing me the opportunity to respond to your follow up questions from the April 21, 2010, House Energy and Commerce Committee, Subcommittee on Communications, Technology and the Internet hearing on "The National Broadband Plan: Deploying Quality Services in the Last Mile." On behalf of the American Public Power Association (APPA), Kentucky Municipal Utilities Association (KMUA) and Hopkinsville Electric System, please find my responses below.

Question 1: *I've long supported the idea of a free wireless broadband network, financed in part by commercials. I know that there is spectrum available for this purpose and there is a proposal outstanding to develop this idea. I would like to hear from the panelists today concerning their viewpoints on this issue: do you believe that a free broadband wireless lifeline can resolve some of the communications issues facing our hardest to reach populations? What other ideas do you support to reach the level of inclusiveness that will hook everyone up at the last mile?*

The three organizations I represent agree that the system of the best fit to the community is always the most desirable to put into place. If this "optimum fit" to the community can be provided by a wireless system financed by those who advertise on it, then that option should be available.

A concern we have with providing a wireless broadband system to a community as a "lifeline" would be that it could become a deterrent to any future systems being offered to meet long-term needs. A similar argument has been used against municipal utilities providing broadband services to some of our communities. Often times when only a basic service is being provided to a community, municipalities are accused of jumping into the market to drive out private industry. The fact of the matter is that the private sector has often refused the communities' requests for upgrades to meet long-term growth and economic development demands, so the communities would turn to the municipal power providers to see if we could meet those requests. Our concern is that merely offering service would not meet the goals of the National Broadband Plan to ensure robust completion along with maximizing the benefits a technology can provide a community.

Because municipal utilities have used a wide range of technologies -- fiber-to-the-home, broadband over power lines, hybrid fiber/coaxial, to wireless -- to meet their broadband needs, the trade associations are "technology neutral." As I stated in my testimony, Hopkinsville uses a mixture of both fiber and wireless to provide and backhaul last mile service to our customers because that best fit our needs and future demands.

On the issue of spectrum availability, APPA has raised some concern over spectrum space to both the FCC and to Members of Congress regarding the need for non-commercial/industrial, privately built broadband capacity for critical infrastructure industries. The FCC has suggested reallocating or repurposing some federal and non-federal spectrumwhich could take allocation away from these industries and to provide it for commercial use. A letter to the FCC from the Utilities Telecom Council, of which APPA is a member, stated "Utilities, oil and gas companies and other critical infrastructure industries certainly can, and will, use commercial broadband offerings for some of their innovative applications. However, mission-critical control and restoration needs cannot be met this way: commercial networks fail to provide the required coverage, reliability and security outside a handful of major cities. Any spectrum made available for wireless broadband services thus should also include dedicated and/or shared spectrum for critical infrastructure industries' communications, which support the safe, reliable and efficient delivery of essential services to the public at large."

Finally, in response to your question on ideas that would support a level of inclusiveness for last-mile hook up, our organizations have been supportive of the Community Broadband Act. This legislation, championed in the previous two Congresses by Representative Rick Boucher (D-VA), would remove any barriers to entry for public power systems to provide advanced communication services. We believe that public power electric utilities should be allowed to help achieve the goal of universal, high-speed broadband deployment if their individual communities entrust them to provide these services.

Question 2: *I'm also a proponent of "dig once" infrastructure projects. I've heard from Secretary LaHood and Chairman Genachowski that they support this concept and it is included in the National Broadband Plan as a way to reach the last mile generally, and especially in hard to reach regions like Indian Reservations. Would each of the panelists give me their perspectives on how this type of program can facilitate their industries or reach underserved and unserved populations?*

In general, the concept of "dig once" for infrastructure projects is a concept our organizations support, i.e.: the construction of a new road and installing new underground utilities at the same time. Frequently, we will try to coordinate projects among our services to adhere to this concept. However, conflicts may arise in the coordination between municipal services and the various services provided by the private sector. The concern is that timelines might not match between services or that essential work might be delayed in order to sync up schedules with other projects.

However, if you are referring to opening one trench for all utilities, based on my experience, you need to be aware of some challenges. When installing utilities in the same trench, electric utilities have to meet National Electrical Safety Code (NESC) for a minimum 36" depth from the surface. However, gravity flow sewer will have less depth at the customer and more at the main on flat ground, possibly causing utilities to cross and resulting, later, in problems locating the utilities. Maintenance can also be an issue with using the same trench. Gas, electric, fiber and water do not always mix well. So, if there is a problem with one, often times an outage will be required of all utilities which could cause an extended interruption of customer service across utilities. Therefore, this concept should be encouraged, but not mandated.

Thank you again for providing us this opportunity to respond.

Hearing on
"The National Broadband Plan: Deploying Quality Broadband Services to the Last Mile"
April 21, 2010

Responses of Jeffrey A. Eisenach to Questions for the Record

The Honorable Anna G. Eshoo

1. I've long supported the idea of a free wireless broadband network, financed in part by commercials. I know that there is spectrum available for this purpose and there is a proposal outstanding to develop this idea. I would like to hear from the panelists today concerning their viewpoints on this issue: do you believe that a free broadband wireless lifeline can resolve some of the communications issues facing our hardest to reach populations? What other ideas do you support to reach the level of inclusiveness that will hook everyone up at the last mile?

A: Efforts to create "free" wireless networks have thus far proven almost uniformly unsuccessful, and in my opinion are not likely to be successful in the future. There are several reasons for this. One is that "free" networks, because they do not depend on consumers for their support, are not subject to the same sorts of market discipline as networks that depend on consumers. The lack of broadband availability is a highly localized problem, in the sense that the solution for serving each unserved area will differ. Wireless solutions will no doubt play an important role in providing availability to many of today's unserved areas.

2. I'm also a proponent of "dig once" infrastructure projects. I've heard from Secretary LaHood and Chairman Genachowski that they support this concept and it is included in the National Broadband Plan as a way to reach the last mile generally, and especially in hard to reach regions like Indian Reservations. Would each of the panelists give me their perspectives on how this type of program can facilitate their industries or reach underserved and unserved populations?

A: I do not have a well-formed opinion on "dig once" infrastructure projects.

The Honorable Kathy Castor

1. Can you expand upon your comments on the USF? What subsidies do you think are unnecessary? Do you believe that subsidies for low-income users will improve broadband adoption rates?

A: First, the USF is providing billions of dollars in subsidies to areas that are served by more than one provider. The existence of a second provider – especially one which has entered the market to compete against a *subsidized* incumbent – is proof positive that no subsidies are required (at least in areas where the service area of the entrant covers all or nearly all of the service area of the incumbent "provider of last resort"). Second, with respect to subsidies for low-income users, the bulk of the evidence suggests that financial subsidies for broadband service, in and of themselves, would not significantly increase adoption rates among low-income households.

The Honorable Cliff Stearns

1. If the broadband plan's analysis is anywhere near correct that 95 percent of the country has access to broadband and two-thirds subscribe, that means that broadband is available to the overwhelming majority of the country. The government has limited resources and we should make every tax-payer dollar count. It is important that the FCC and Congress engage in a cost-benefit analysis when deciding what aspects of the broadband plan to implement and how. Is it better to spend money and focus government efforts in areas of the country that don't have access to broadband, such as Tribal lands and other high-cost areas that are uneconomic for the private sector to serve, before areas that do have broadband?

A: Yes. There is no apparent public policy rationale for subsidizing duplicative broadband services. The more difficult issue is how to treat satellite providers, whose service territories are not defined by the geographic limits of a wireline infrastructure. In order to avoid discriminating against these providers, it would likely be necessary to design a consumer-centric (as opposed to provider-centric) system.

2. If we subsidize "underserved" areas where there is already at least one commercial provider, instead of just unserved areas, don't we cause more harm than good by splitting the subscriber base in a high-cost area and making it harder for both the unsubsidized and subsidized provider to succeed?

A: That is correct.

3. Do you agree that the FCC must do a much better cost-benefit analysis before we actually start subsidizing broadband through the universal service program in the way the broadband plan proposes?

A: The USF Program envisioned in the National Broadband Plan would involve spending tens of billions of dollars over the course of many years. A comprehensive and analytically sound benefit-cost analysis surely should be a precondition for such a large public spending program. In my opinion, no such benefit-cost analysis has been performed to date.

4. If we are trying to promote broadband deployment, does it make sense to tax broadband service by assessing universal service fees or other charges on it?

A: In my opinion, it would be preferable to fund any broadband subsidies out of general tax revenues rather than from a tax on communications services in general or broadband in particular.

5. If we are trying to promote satellite broadband, does it make sense that the FCC International, Engineering, and Wireless Bureaus just placed conditions on SkyTerra

restricting its ability to sell wholesale services to AT&T and Verizon? Don't such conditions also harm our goal of promoting wireless broadband? Is there any economic justification for restricting a commercial provider from striking voluntary deals with AT&T and Verizon?

A: The FCC has not, in my opinion, provided a valid public policy rationale for the restrictions in the Skyterra Order, nor is it likely such a rationale exists. The U.S. wireless market is the most competitive in the world, and efforts to alter artificially the industry's structure by advantaging some competitors over others are likely to harm consumer welfare.

6. If municipalities are going to provide broadband, should it be targeted to areas where it is uneconomic for the private sector to offer service? What are the economic consequences of inserting municipal broadband into markets where there are already commercial providers?

A: In general, efforts by municipalities to operate broadband services have proven unsuccessful, and in my view are not likely to prove more successful in the future; and, they are less likely to be successful when they are operated in competition with commercial providers. The consequences of doing so are to reduce incentives for investment by commercial providers while at the same time wasting taxpayer resources which could be put to better use elsewhere. That said, as I have indicated elsewhere, lack of broadband availability is a localized problem, and there may be particular instances where a municipality or other government agency can play an important part in the solution, even including providing service to otherwise unserved areas.